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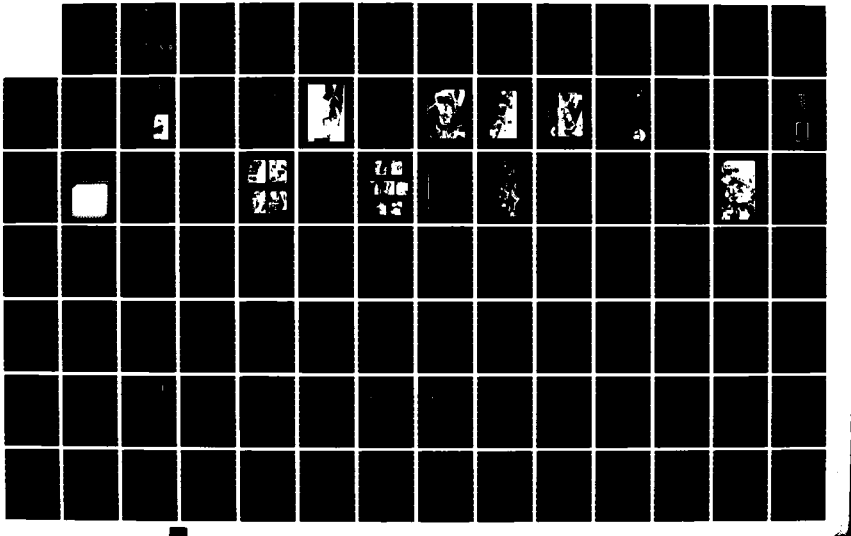

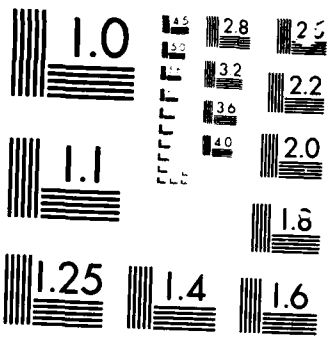
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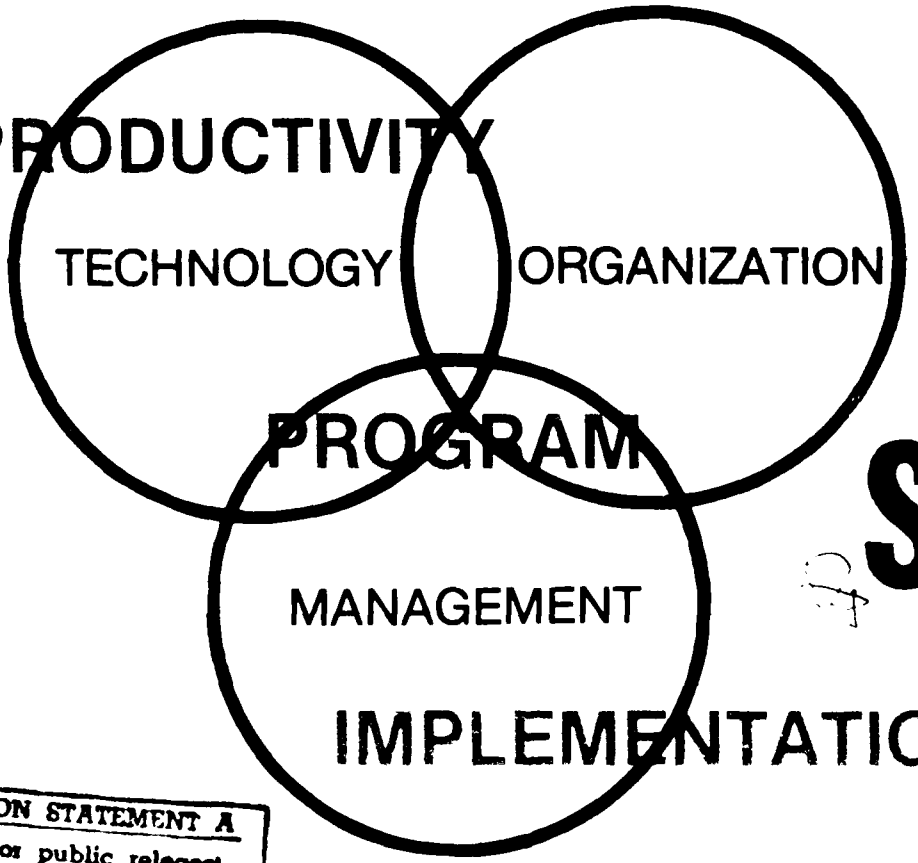
AMERICAN DEFENSE PREPAREDNESS ASSOCIATION

CONFERENCE PROCEEDINGS OF THE PRODUCTIVITY PROGRAM IMPLEMENTATION CONFERENCE



NAVAL AIR STATION
JACKSONVILLE, FLORIDA

CONDUCTED
MAY 20-22, 1981

AMERICAN DEFENSE PREPAREDNESS ASSOCIATION

PROCEEDINGS

OF THE

PRODUCTIVITY PROGRAM

IMPLEMENTATION CONFERENCE

Program Co-Chairmen:

Dr. William B. Simecka, University of California Lawrence Livermore Laboratory and Chairman of the ADPA Management Division

Dr. J. W. Tweeddale, Director of Productivity Management, Department of the Navy

Naval Air Station
Jacksonville, Florida

20-22 May 1981

CONTENTS

Due to technical difficulties with the recording equipment, some portions of the proceedings were not recorded and have been reconstructed, when possible. We regret, also, that introductions of some of the speakers were not recorded.

PRODUCTIVITY PROGRAM IMPLEMENTATION CONFERENCE

SESSION 1

EXEMPLARY PRACTICES IN PRODUCTIVITY

Dr. William B. Simecka

It is a real pleasure for the Management Division of ADPA to sponsor this important conference. To some, productivity may only be a buzz word, as many buzz words crop up in our kind of business. But the rising competitiveness of our potential military adversaries, as well as our economic competitors in the world market, make the improvement of productivity throughout the U.S. a serious business. All organizations in both private and public sector should not be left untouched in this business of picking up and improving productivity. Of course, it takes the right attitude of management and employees to do that. Hopefully, this last year is the start of a gradual and continuing improvement where the United States can now enjoy the kind of superiority and the lead in that superiority that it had in the past.

We have gotten together, we think, a very good program with some excellent presentations. It is our hope that this conference will stimulate all of us to adopt a proper attitude toward the improvement of productivity and hopefully we will pick up some new approaches that we can take back to our respective organizations to help that productivity along. If we can achieve just this, or a portion of this, then we will consider this conference eminently successful.

It is now my pleasure to present our host, Captain William C. Christenson, Commanding Officer of the Naval Air Station, Jacksonville, and he, of course, has done a great deal to help us put on this conference. Captain Christenson.

Captain William C. Christenson

Good morning, gentlemen. It is indeed a pleasure to welcome you to the Naval Air Station, Jacksonville. I have had the opportunity to go through your list of members, your organizations, your officers, and I must tell you that I personally applaud your individual efforts. The dedication of your time, your talents, and your expertise to the entire group oriented toward the enhancement overall of the defense of this country is indeed laudable. At this time, I am not personally involved as far as being on the cutting edge of the first line of defense, nor am I personally involved in the high technology of R&D, but I am very much involved in the support of those units that are the first line of defense.

In that capacity, the Naval Air Station employs overall some 18,000 personnel, both military and civilian. The majority of those belong to the tenant commands that are served here, and there are some 89 of those that are directly involved with the U. S. Navy. I even have some that aren't directly involved - members from other nations. But I sincerely appreciate your being here. I do appreciate your efforts, and I know that your meetings are going to be productive. I hope while you are here that you will feel free to call upon me for anything that I might be able to do to either enhance your meetings or personally to make your stay more pleasant. I do sincerely welcome you aboard.

It is my privilege at this time to introduce your keynote speaker for the day. He is a gentleman with a long, distinguished naval career that started in 1945 upon graduation from the Naval Academy. He spent the first few years of his career on destroyers; he saw the light and went to the submarine force, where he served as Ships Company Executive Officer and Commanding Officer of conventional type submarines. Following a tour as CO of a conventional submarine, he went to nuclear propulsion school and came back into the Fleet. He served as Commanding Officer of the USS Seawolf, SSN 575, and was the first Commanding Officer of the Blued Crew on the Andrew Jackson, SSBN 619. He served in that capacity for a total of four years, which for any Commanding Officer is an optimum period of time. Two years is far too short. Following his operational tours on nuclear submarines, he proceeded to broaden his scope by going to the Chief of Naval Operations. During his career, he has served on the Staff of the CNO a total of four times - and that's extremely broadening. Interspersed among those, he was the Commander of Submarine Squadron Six, Submarine Flotilla Six, and served as Chief of Staff at SACLANT. His final tour in the Chief of Naval Operations was as DCNO for Logistics, OP-04, which he left in 1978 to assume his current duties as the Chief of Naval Material. Early on in his career, this gentleman saw the light, went from surface to submarines and I'm afraid at this stage of the game that we're not going to be able to really show him the light and get him from submarines to naval aviation.

It is indeed my privilege and my pleasure at this time to present to you the Chief of Naval Material, Alfred J. Whittle, Jr., Admiral, United States Navy.

Admiral A. J. Whittle, Jr.

Thank you very much, Bill. As a matter of fact, at the time I went into submarines, I really wanted to go into aviation but I wasn't eligible at the time.

Many, many times in the course of a year, someone stands up in front of a group like you and says, "We stand on the threshold of a time characterized by unprecedented global challenge and enormous opportunity." Usually he means it. Usually, it's a somewhat limited opportunity. And usually, he's probably right.

In this case, I mean it, I don't think the opportunity is limited in any way, and I think we have a challenge today which if not met, will surely, over time, lead to the demise of the United States as a world power. It is my view that productivity enhancement can meet that challenge and help us to maintain our eminent position in today's global economy. It is an opportunity in this conference, with its theme of productivity program implementation, to share ideas, practices, and visions on productivity. It is an opportunity for industry and government to explore successful experiences and build a framework for the future.

I have spoken many times in the past on national defense issues and time and again, the management of beneficial change and the infusion of the productivity force into the fabric of your organizational lives has surfaced.

The process of improvement requires commitment, discipline, and leadership, but I would remind you that those are necessary but not sufficient conditions.

Business Week, in a recent survey of this nation's most productive companies - and a majority of them are in defense industry and many of them do business with the Navy - found that all of those companies shared the following attributes.

The first is "a bias toward action." The organizations that are most productive have an operating climate that encourages "doing it, trying it, fixing it." They avoid endless analyzing and studying to death the products of the organization. The attitude of management in these most successful firms is "get some data, do it, adjust it," rather than endless planning or waiting for a perfect plan. They tend to strongly solicit ideas which are quickly tried out and those that work are pushed hard. A few well defined goals are set for the managers; the organizations are able to quickly focus on problems.

The second characteristic of the successful firm is a simple organizational form and a lean staff. Some of our best Navy PM organizations demonstrate this characteristic. The activities are kept small and manageable to facilitate communications and decision-making. The message is "to be lean and focused is to be productive and effective." Large successful organizations stress small action-oriented work groups as a major factor in their success.

The third attribute is a closeness to the customer, that is, they are customer driven, not technology, product, or strategy driven. This is a principle that all of us need to think about a little more. In the press of business and the everyday rush to get things done, managers often become process oriented, forget the mission, forget the customer. In a recent MIT study of fast-paced industries, it was found that the majority of new product ideas and most of the product improvement ideas came from customers. Our

most effective Navy support organizations maintain close, intimate contact with the Fleet that they serve. In these organizations, the Fleet is not viewed as some abstract function, but rather as a specific set of organizations and individuals. Ike Kidd had it absolutely right when he continually asked the Naval Material Command, "What have you done for the Fleet today?"

Another quality of a productive organization is productivity improvement through people. Within the Navy, the recent success of the Quality Circle organizations at Norfolk Naval Shipyard, at the Naval Ordnance Station, Louisville, at the Naval Air Rework Facility at North Island, are examples that suggest that motivation and stimulation of our employees to increase productivity is an area of management effort that should receive increased emphasis. People are the point of entry into any organization, not technology, not systems, not processes, but people. I am delighted that there is a session of this conference which is devoted to the people part of productivity. Quality Circles, labor management relations, and job enrichment are tools; the challenge is to elicit a genuine sense of concern among our people for improved productivity.

Another attribute of effective management mentioned by Business Week is the existence of autonomy to encourage entrepreneurship. Managers must be given responsibility to act, to take risks, to demonstrate ownership of their positions, and to reap the rewards of their efforts. In the Department of Defense, there is renewed sentiment for moving the fiscal and management responsibility downward for program management. Within the Navy, it is our philosophy to push responsibility to the lowest level that can manage it. We in the defense industry must create a climate to encourage and protect entrepreneurial and innovative management if we are to survive as an economy. The world has never found an effective replacement for Yankee ingenuity.

Successful organizations also stress one key business or organizational value. Statements of mission must be clear with concrete goals to create a focus and a structure for their achievement. High performance, productivity, and effectiveness are the products of assertive goal-centered management. Some of our finest commercial and military-civilian organizations have achieved success because some visionary manager was able to infuse the organization with a clear sense of purpose. In these organizations, everyone has a clear sense of priorities and what is important. The outstanding leaders in both the Navy and our defense industry stress an important busienss value within the organization and then develop a climate which assures its achievement.

A seventh attribute of productive organizations is their emphasis on doing what they know best. Working on the right thing is what management is all about. In our best organizations, much organizational effort is expended focusing resources where strength and advantage are present.

Finally, the eighth attribute of organizational excellence I wish to touch on is that of maintaining simultaneous loose-tight controls. This sounds like a contradiction, but successful managers will recognize this attribute as one of judgment in knowing where to keep a tight rein on things and where to let your organization run. Extremely productive organizations have rules and structure which control a few key variables tightly but allow looseness and flexibility in others. As organizations grow, it is very difficult to maintain this balance which is so necessary to assure both concrete direction and attention to productive results, coupled with the ability to rapidly respond to demand and change.

Examination of these productivity attributes and their occurrence in the best organizations suggests that these organizations pursue excellence through relentless perseverance, through repetition, and an emphasis on simplicity over time. Moreover, a sense of caring, of vision, of dedication, and of internal partnership pervades their efforts and the quality of their results.

I suggest to you here that the time has come to rededicate our collective enterprise to the same standards of excellence and productivity achievement characterized by our best organizations. Consider the following factors existing at the moment which provide a strong supportive climate for a successful partnership. There is strong support from the Administration, including numerous pronouncements supporting termination of the Government-Industry adversary relationship; there is strong Congressional support, including a number of budget and legislative initiatives strengthening the public support of the defense establishment; there are recent internal Department of Defense directives which stress the theme of decision delegation and acquisition process simplification.

To the end of improving the defense acquisition process, 31 separate recommendations and issues have been approved for prosecution in the Department of Defense by Secretary Weinberger. These include emphasis on mechanisms to facilitate acquisition program stability; provide more delegation of responsibility to the service program manager; emphasize evolutionary technology alternatives; fully fund all approved programs; emphasize readiness and sustainability of deployed weapons; and strengthen the defense industrial base. Specifically included in the initiative to strengthen the defense industrial base are such issues as encourage and incentivize capital investment in the private sector to increase productivity; increase risk sharing and contractor performance incentives; stabilize production through multi-year contracting; minimize program changes; simplify DOD procedures, regulations and directives and redirect legislative requirements to facilitate performance by both DOD and the defense contractors; incentivize performance to achieve reliability and maintainability goals; and to shorten the total acquisition process.

You will note that if one applies the attributes of the productive organizations I have previously cited to the current defense acquisition situation, the initiatives that fall out of this comparison are markedly similar to those I have just outlined.

Furthermore, the basic issue of productivity is imbedded in every one of these initiatives, as is the need for a government-industry partnership to achieve the benefits clearly obtainable from the mandate that we have been given.

What you will explore in the next two days are the dimensions of the productivity equation and the current program posture, both within the Navy and the defense industry. Such facets of the productivity enhancement effort as organizational development and the quality of working life, the application of productivity enhancing technology, and the management process which accompanies these efforts will be presented. I want to challenge you to view these presentations from a broad perspective, not merely as cookbook solutions to specific problems.

We often hear of our Japanese competition and the nature and statistical measure of their productivity achievements, and our great need in this country to have a healthy, internationally competitive industry and economy in order to also have a strong national defense. As I view our defense industry from an international perspective, it is obvious that dedication and emphasis on a few generic but finely-tuned principles is what has made our competition so successful. I am convinced that a dedication to quality and excellence in the conduct of our defense business and adherence to sound basic principles of management in a government-industry partnership will result in a stronger and more productive industrial base.

High productivity and a climate of excellence and achievement are characteristic of our best organizations. They must be an integral part of our Navy-industry partnership. With a new sense of dedication and a realization that the time and tides of Americans were never more ripe for such a commitment, I challenge you to make it so.

Dr. Malcolm R. Currie

I am delighted to participate in this conference and to comment on the crucial subject of productivity from a defense industry viewpoint. I have much to learn in this area and there are many experts here to learn from; but I am a novice who:

a. Used to be very concerned when I was in the Defense Department about unit costs and affordability -- and participated in the early days of D.T.C. which is really an essential element of what we now call productivity.

b. And now, as someone concerned with getting high quality hardware out the door on as efficient basis as possible -- sometimes successfully -- and as someone who, like many of you, has his nose rubbed daily in questions of effective transition of products from engineering to production, of what constitutes good design, of capital investment decisions and of their intimate relationship with questions of cash flow from contracts, return on investment -- and of the enormous impact on all of this by inflation and high interest rates in recent years.

I think we can all be encouraged by the current mood of the country. Renewed interest -- and hopefully even some understanding --of those factors which in the past has made this the most productive, innovative, highest-standard-of-living society in history -- but which have been lost in recent years and has led to this stagnation, this losing of ground relatively to other societies which have learned well the lessons and principles which we created but have seemingly forgotten along the way.

And what is true of our industry in general is particularly true in the defense sector, which has its own special characteristics: emphasis on advanced technology, as an explicit part of our defense strategy; limited production runs by commercial standards, often with many changes along the way; and its special financial and management constraints as imposed by statute, by DOD practice, and by unpredictable political factors -- altogether an enormously inefficient process but, by the same token, an area of enormous opportunity for improvement, and that's precisely what this conference is addressing.

I should note, along these lines, the encouraging climate for change in DOD. In particular, the wide-ranging Carlucci directive of April 30, if vigorously and thoughtfully implemented by DOD, can lead to major improvements in the acquisition process and major gains in productivity.

Now when one thinks about productivity, the popular cliche is the vision of production lines automated with robots, minimizing human touch labor and thus producing cheaply. But, of course, it is much more than that, particularly in the defense business. It embraces, besides focuses on manufacturing per se: management attitudes; stimulation of innovation; the engineering process; government policy; the human factor - have we recruited and trained and motivated people --in short, everything we do. The automated production line is often, in fact, a minor part of the total in our business. The percentage of total cost in actual touch labor in most of our sophisticated products is usually quite small, less than 20 percent and others less than 10 percent.

Rather than discuss productivity in its generalities, I am going to quickly run through a number of specific examples of what is happening in increasing productivity in engineering, innovative use of technology, in production, and by people in our business, and then draw from this some common threads and some conclusions which I believe may be relevant for all of us. I'll be talking about the electronics-oriented segment of defense rather than aircraft or vehicle or ship-oriented parts.

First, a few comments about engineering productivity. The popular focus for years has been on improving performance of people on the factory floor, by special tools, methods, and worker incentives. This has served us well. But real action these days, especially in aerospace, is upstream from that - in the product design and production process evolution.

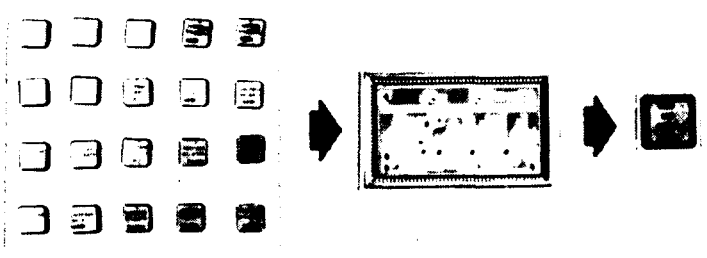
In chart number 1, the quotation of 10-12 years is still true today.

Chart number 3, in more detail, shows qualitatively where the high payoff areas are in influencing production unit costs of missiles. It is intended to illustrate the point that we spend lots of time working on smaller payoff areas and now need to focus on the big ones; they are perhaps harder to address but have enormous leverage. In all this, the computer is the ubiquitous productivity implement tool. It is in wide use today and is literally revolutionizing the way we do our engineering and the way the completed engineering is used in the production line.

Chart number 4 shows an example. CAD allows mechanical to visualize the product in 3D to optimize design, and avoid design flaws. Mass properties calculation time is reduced by five times. Modeling for stress analysis has been reduced by a factor of 10. As I'll indicate later, electronic design is also being revolutionized.

PRODUCTIVITY

SOME EXAMPLES FROM AEROSPACE



PAYOFF FROM PRODUCTIVITY EMPHASIS

"DESIGN IS 10 X METHOD

METHOD IS 10 X EFFORT"

PROF. J. CARRABINO
UCLA MANAGEMENT SCHOOL

FACTORS WHICH INFLUENCE PRODUCTION COST

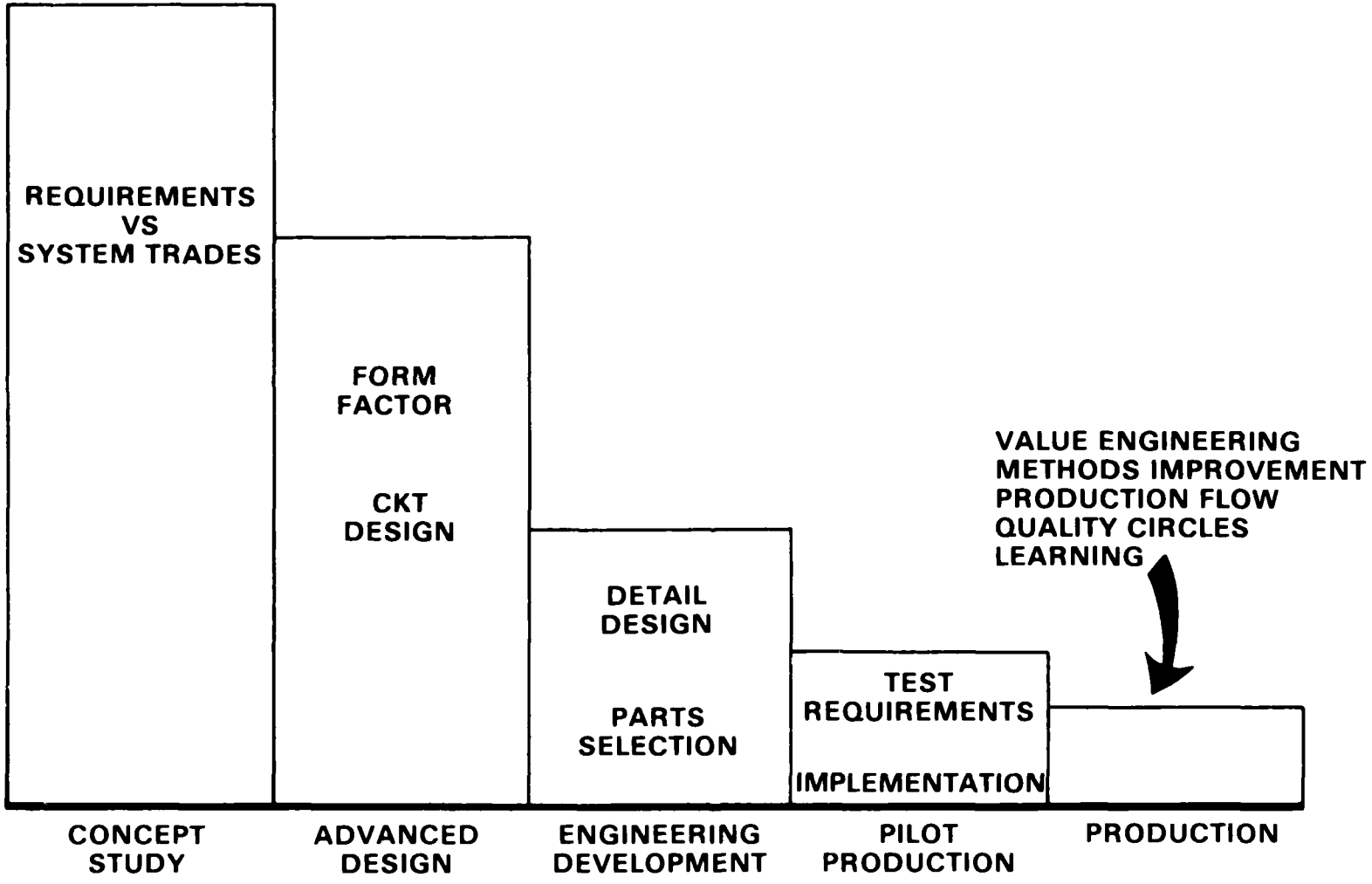


CHART NO. 3

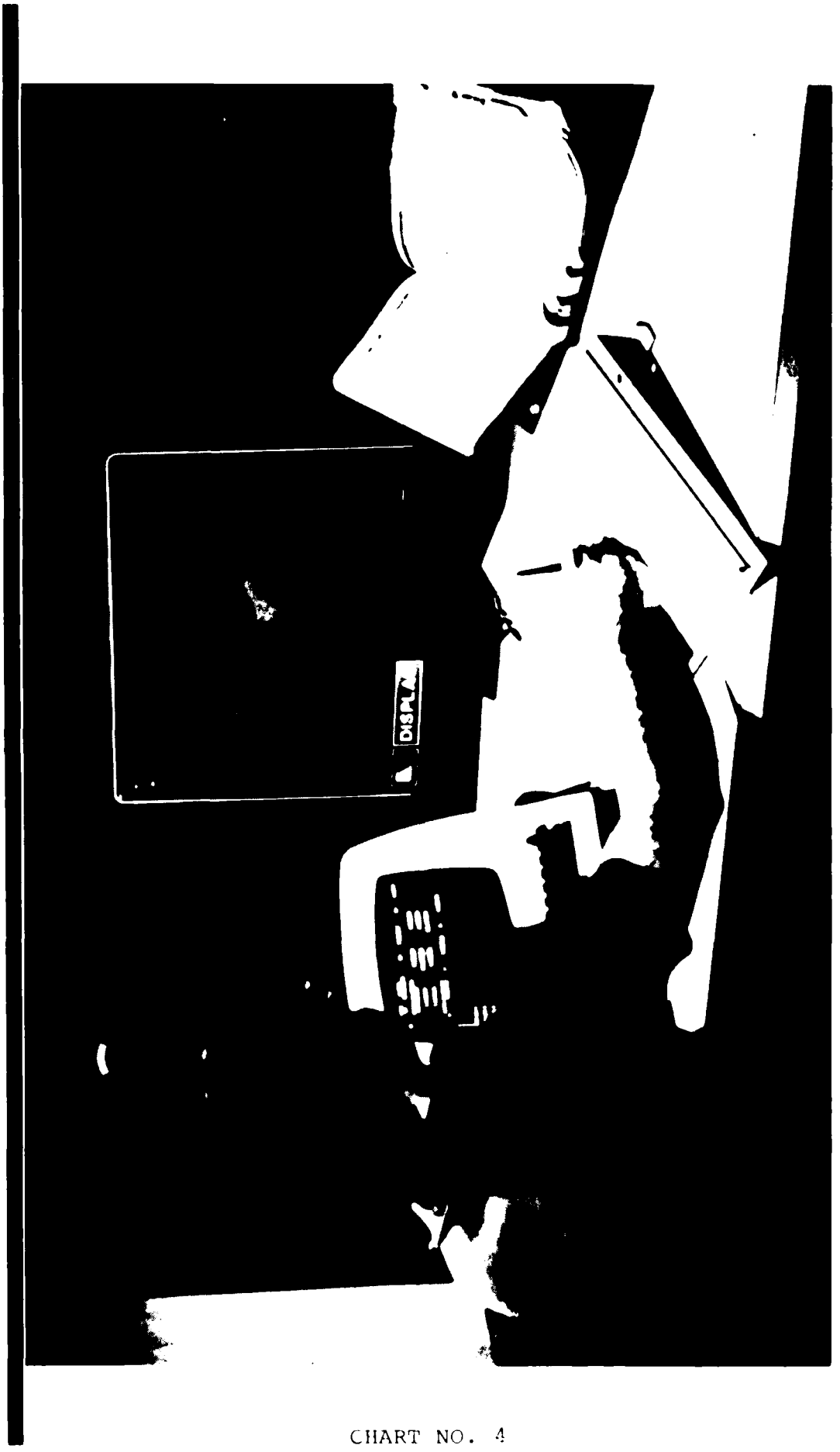


CHART NO. 4

Chart number 5. As another example in my business, computer-driven performance stimulation uses real hardware with computerized drive and data analysis. It saves many millions of dollars in building and flight testing of missiles and is far more complete in evolving and validating designs.

Chart number 6. A modern drafting room, with computer aids, which cuts drafting time by a factor of 5, with fewer errors.

Chart number 7. Design information is captured on a centralized product configuration computer. The data can then be used by a variety of people and organizations, as shown here.

Chart number 8. We have not yet completed this, but as it evolves, we expect major productivity improvements over manual systems in configuration control, accounting, change control, purchasing, inventory control, and ultimately direct factory release on digital tapes and tool control, all major elements of cost in producing defense systems.

Chart number 9. This shows the productivity improvement for just one part of that process, namely, factory planning and N/C tool control.

Chart number 10. Along with these very real and tangible changes in the engineering process per se, there are enormous strides being made now and possible in the future due to the basic technologies of our business, such as electronics (here showing transition from integrated circuits to complex hybrid circuits to custom LSI). Let me show a couple of examples.

Chart number 11. Custom hybrid circuits are a key part of most of our products -- often involving dozens of complex integrated circuit chips, and many hundreds of hand-bonded gold wire interconnects. They are very expensive to design, to produce, and to test. We have been able to streamline that process with improved design rules, test access, assembly methods - and most of all, to directly design with a computer and to use that computer data base directly in various automated production and testing techniques.

Chart number 12 shows reduction in the engineering time for these complex hybrids. We expect to realize even greater improvements in manufacturing and test costs; we also expect simultaneous great increase in product quality.

Chart number 13. Another way to achieve productivity is to partition circuits so that major portions of them are amenable to custom LSI. Whenever that is possible, it allows dramatic improvements in time and cost by riding on the coat-tails of the huge investments in LSI technology generated by the commercial semiconductor industry. This illustrates a configurable gate array approach, which uses a general purpose

SIMFAX

CHART NO. 5

COMPUTER AIDED DRAFTING

CHART NO. 6

DESIGN CAPTURE COMPUTER CENTER

CHART NO. 7

PRODUCTIVITY IN ENGINEERING DATA MANAGEMENT

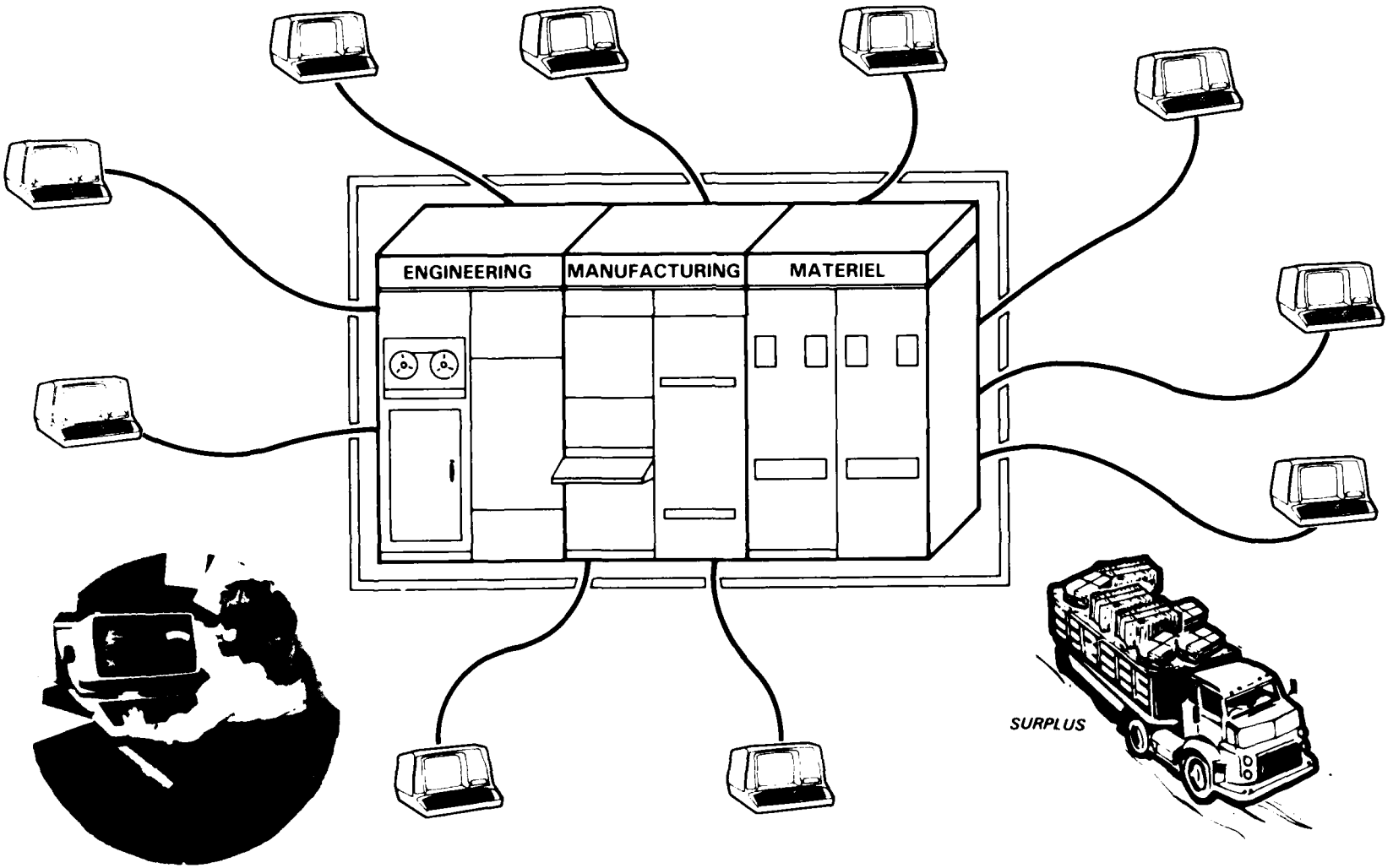
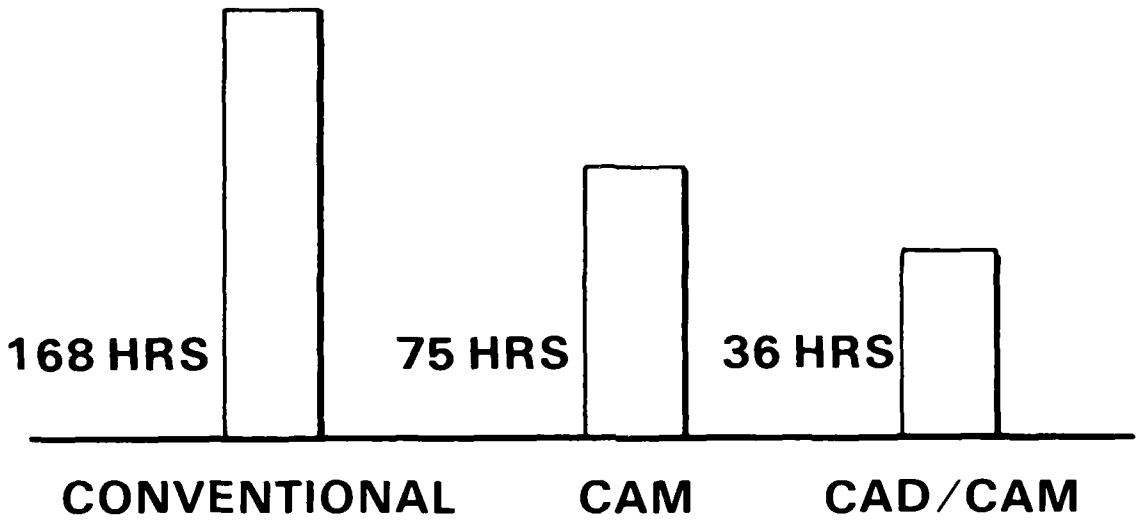


CHART NO. 8

PRODUCTIVITY IMPROVEMENT IN PLANNING AND N/C PROGRAMS



"CONVENTIONAL" = ALL MANUAL

"CAM" = ENGINEERING DATA DIGITIZED PLUS MENU-TYPE PLANNING

"CAD/CAM" = FULL DIGITAL INTERFACE FROM CAD.

CHART NO. 9

ELECTRONIC PRODUCTIVITY

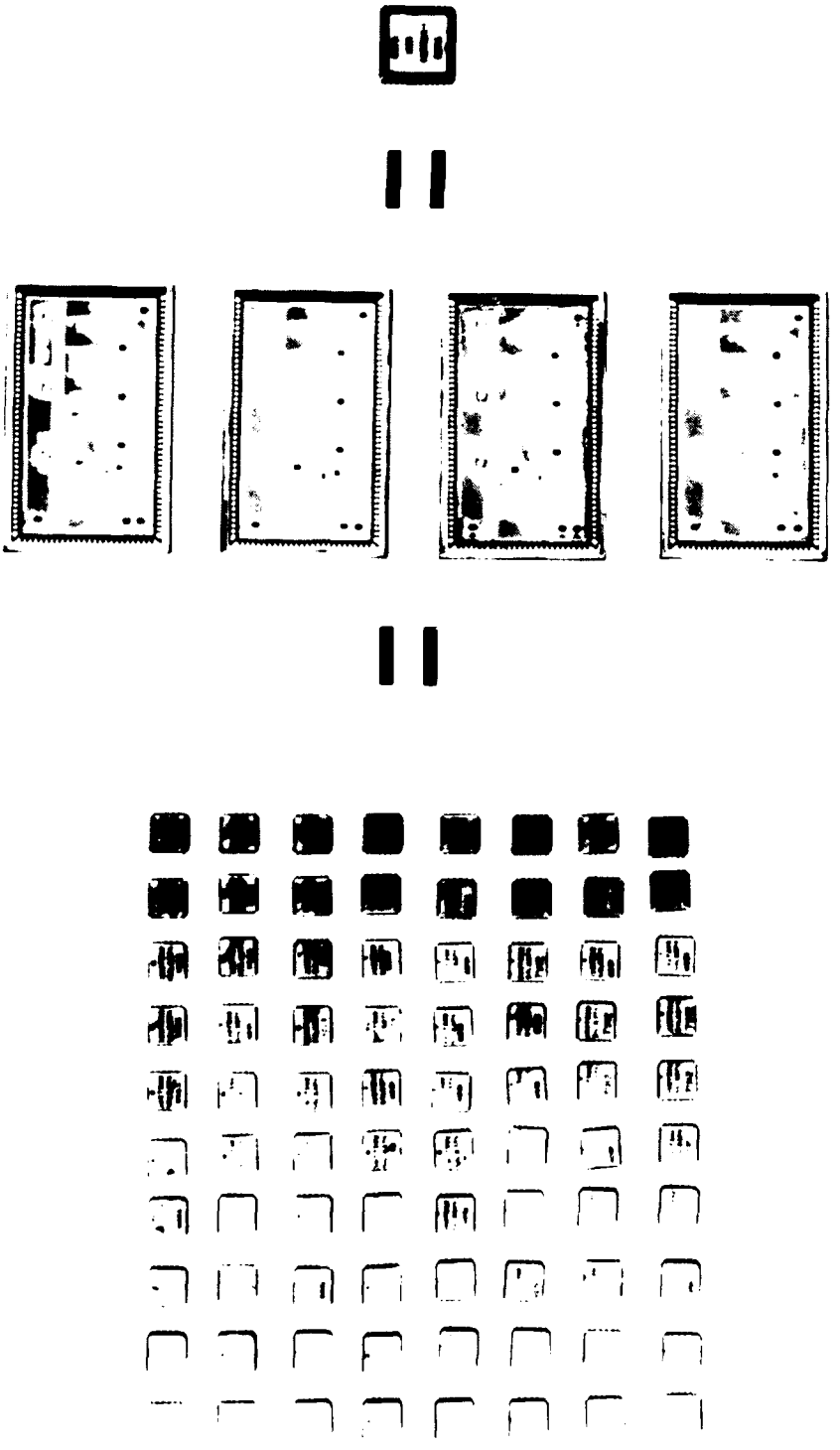
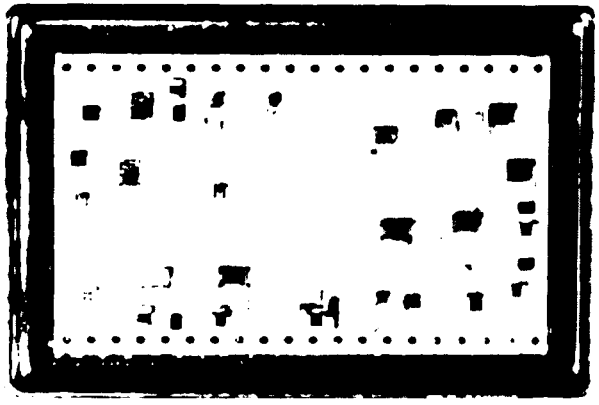


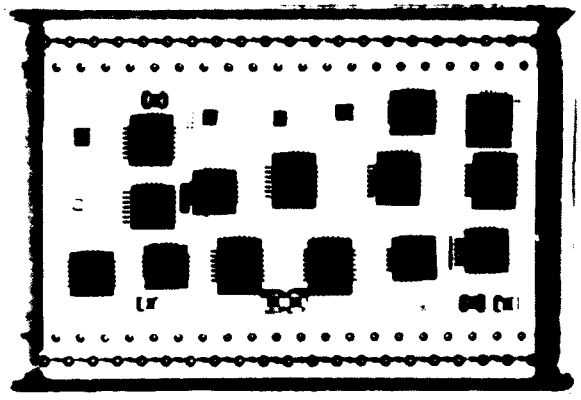
CHART NO. 10

COMPLEX HYBRID CIRCUITS —
MAJOR GAINS IN DESIGN & PRODUCTION EFFICIENCY

SINGLE LAYER CHIP
AND WIRE



STANDARD PADS MULTILAYER
NONHERMETIC CHIP
CARRIER



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SCALE, INCHES

COMPLEX HYBRID DESIGN DEVELOPMENT TIME

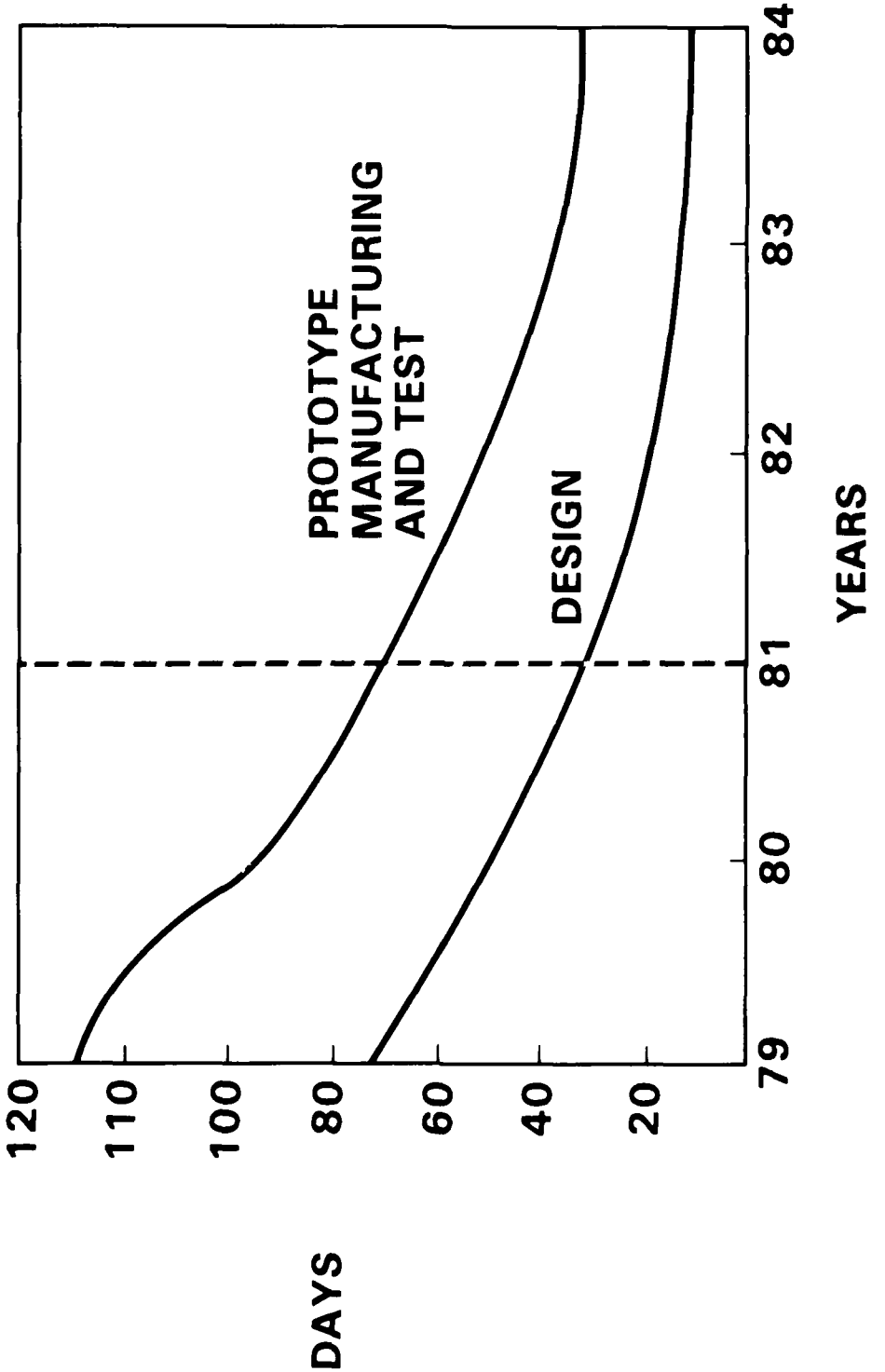
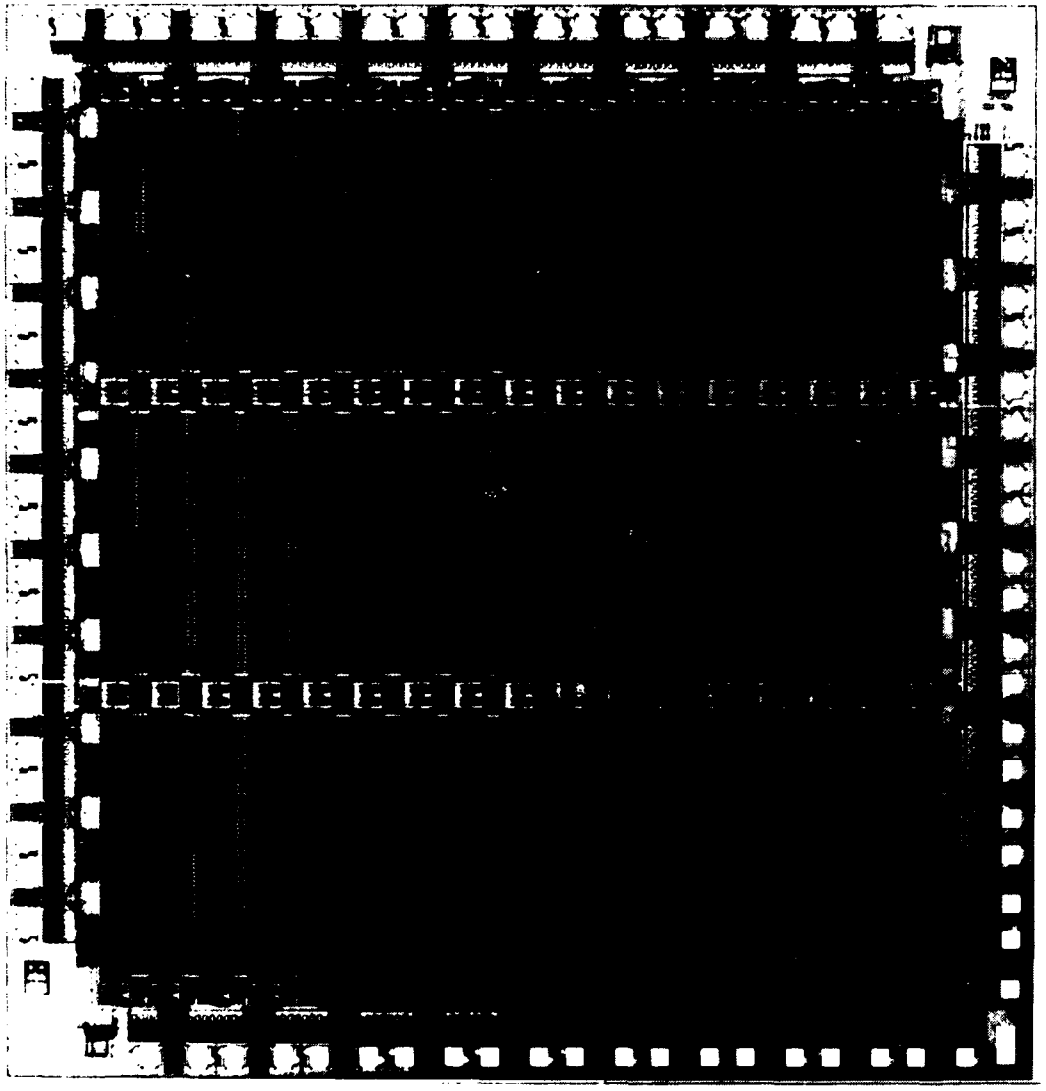


CHART NO. 12



H1084
CONFIGURABLE
GATE ARRAY

part of a well-established technology. The specific function of the part is determined by the last layer or several layers of metallization interconnecting the thousand gates and hundred or so buffers on the array. We have established a detailed interface at the digital tape level with a number of suppliers using various semiconductor technologies. Everything is on a computer - the design, the simulation, the artwork, the production.

Chart number 14 shows how the less time for obtaining good parts has decreased as these interface procedures have been optimized. Besides time, there are dramatic cost, weight, and space savings with this approach. For example, in a typical missile, we believe we can replace about half the hybrids with this form of custom LSI at a savings of often $10,000 per unit or more. These are big numbers when you're in high-rate production.

Now let me comment briefly on some other aspects of manufacturing productivity, mainly to create a specific visual impact to further buttress a major conclusion from all this.

Automatic test (chart number 15A) - again the pervasive use of the computer in our business. Chart number 15B shows the kind of savings and increase in productivity which result. Chart number 16A is another example, this one becoming fairly common - but look at the equipment required. And again, (chart number 16B) the direct savings which are being realized.

Chart number 17A illustrates a mechanical manufacturing system which we will have on-line within several months. It is geared to making limited runs (10s to 100s) of many kinds of products at the same time, which typifies much of the defense business....again, computer dominated (chart number 17B) with the dramatic improvements, both in productivity and in quality, as well.

From these few examples - and there are many more like them - we can easily see explicitly the common themes or common elements throughout the design, the engineering, and the manufacturing processes which are leading to these enormous gains in productivity, namely (first) the pervasive and increasing use of the computer, and (second) with it, the huge capital investments required to bring about this revolution.

With respect to the computer, it doesn't require fringe benefits, it doesn't require constant increases in compensation, it leads to repeatability, higher yields, and quality. But let me suggest a couple of problems DOD may have to cope with its use.

First, as we place a design in an integrated engineering and production computer data base, that design must obviously be compatible with particular manufacturing processes; drawings

CONFIGURABLE GATE ARRAY
LSI DESIGN TIME

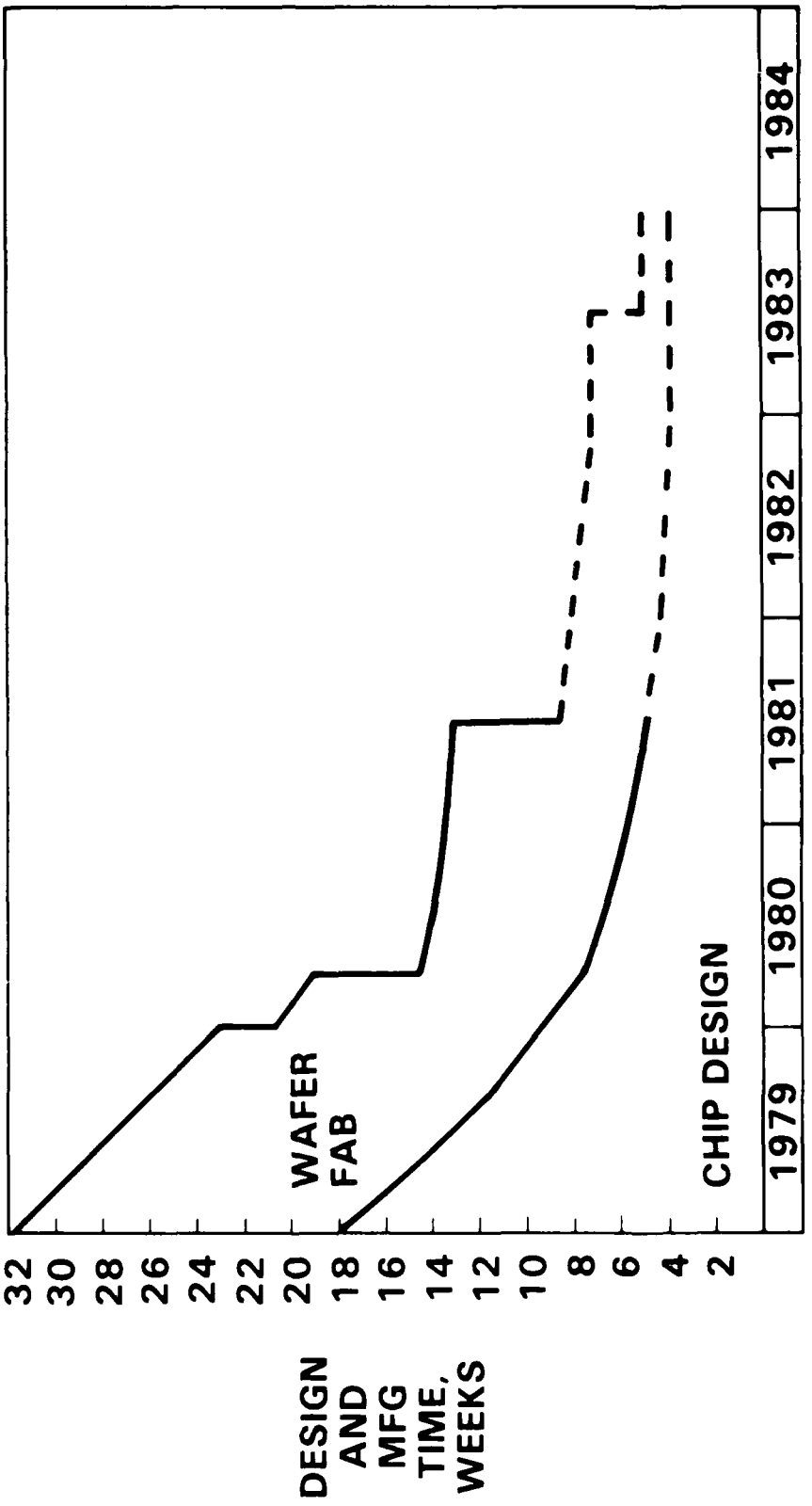
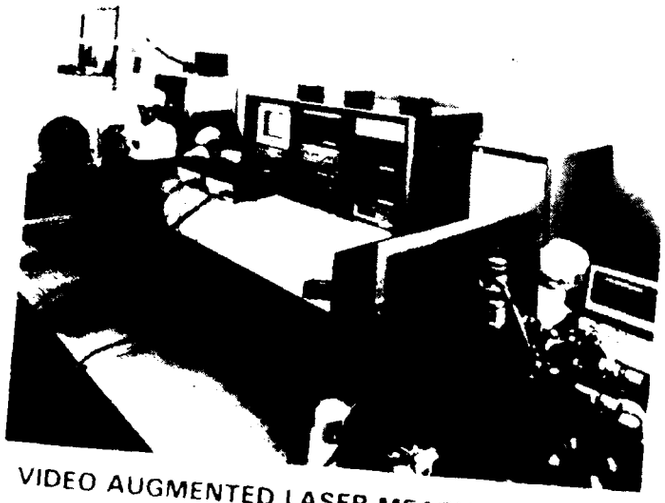
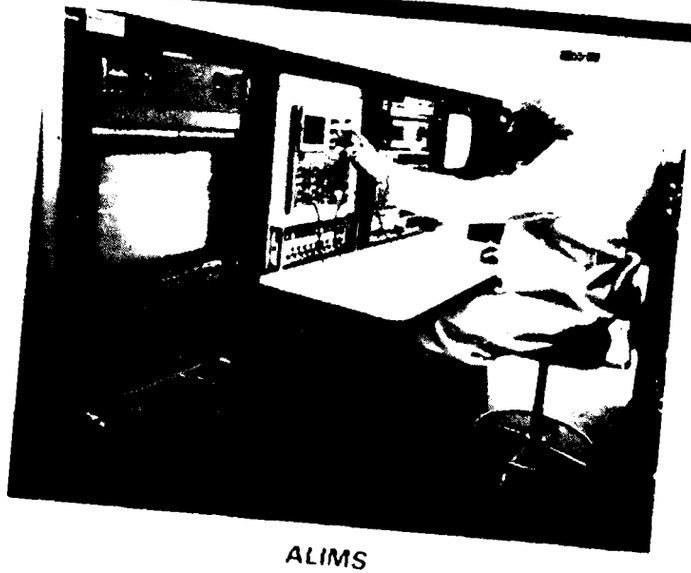


CHART NO. 14

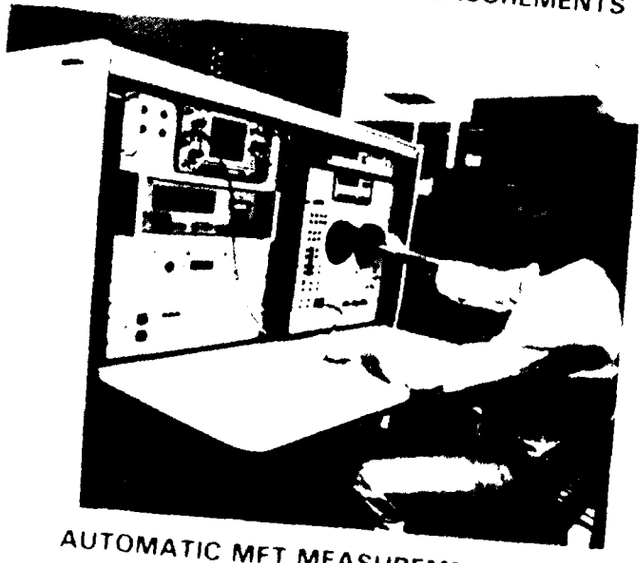
AUTOMATIC TEST



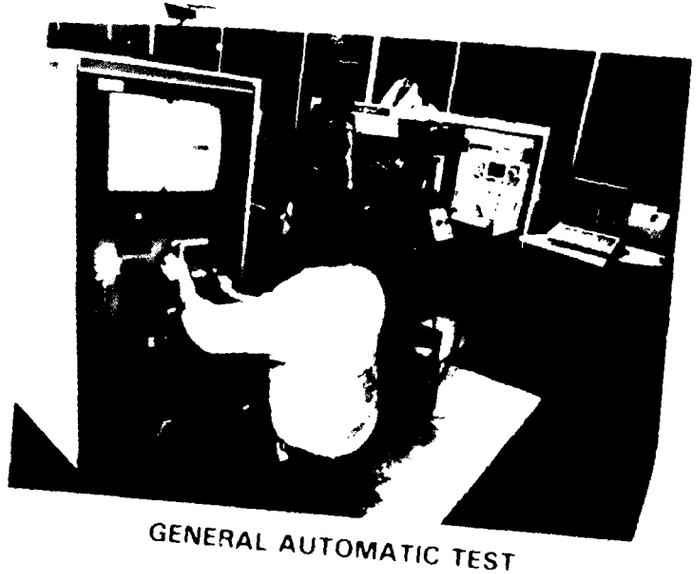
VIDEO AUGMENTED LASER MEASUREMENTS



ALIMS



AUTOMATIC MFT MEASUREMENT



GENERAL AUTOMATIC TEST

PRODUCTIVITY AND MANUFACTURING
MANUFACTURING TECHNOLOGIES AND FACILITIES

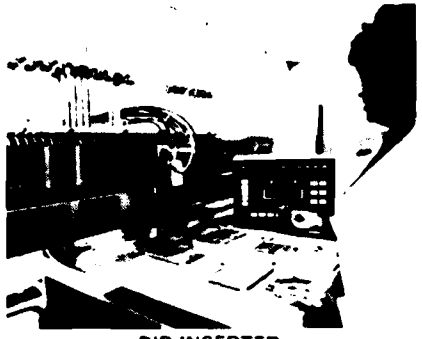
AUTOMATIC TEST

PRODUCTIVITY ENHANCEMENTS	DIRECT LABOR REDUCTION
• VIDEO AUGMENTED LASER MEASUREMENTS	75%
• ALIMS: AUTOMATIC LASER INSTRUMENTATION AND MEASUREMENT SYSTEM	70%
• AUTOMATIC (MFT) MODULATION TRANSFER FUNCTION MEASUREMENT	80%
• GENERAL AUTOMATIC TEST	66%

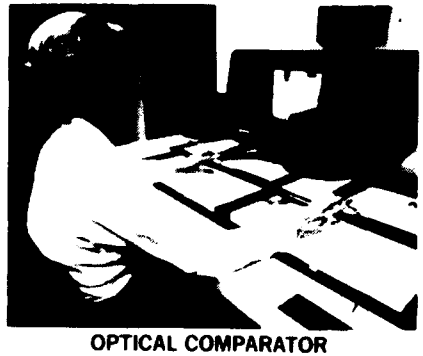
CHART NO. 15-B

AUTOMATED CIRCUIT CARD ASSEMBLY AND INSPECTION

COMPONENT SEQUENCER VERIFIER



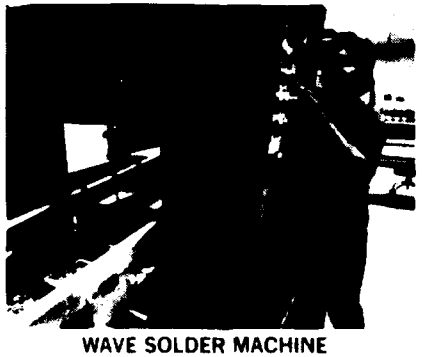
DIP INSERTER



OPTICAL COMPARATOR

SEMI/AUTOMATIC INSERTER

VCD (AXIAL-LEADED COMPONENT) INSERTER



WAVE SOLDER MACHINE

ELECTRICAL ASSY INSPECTION (BED OF NAILS)

CHART NO. 16-A

PRODUCTIVITY IN MANUFACTURING
MANUFACTURING TECHNOLOGY AND FACILITIES

AUTOMATIC CIRCUIT CARD ASSEMBLY AND INSPECTION

PRODUCTIVITY ENHANCEMENTS	DIRECT LABOR REDUCTION
• SEQUENCER/VERIFIER	50%
• VCD AXIAL LEAD COMPONENT INSERTER	75%
• DIP INSERTER	87%
• CS 400 COMPONENT/LOCATOR/INSERTER	50%
• WAVE SOLDER AND FLUX/CLEANING SYSTEM	80%
• OPTICAL COMPARATOR	66%
• BED-OF-NAILS	80%
• SYSTEM SUMMARY LABOR REDUCTION	75%

CHART NO. 16-B

2R

AUTOMATED BATCH MANUFACTURING SYSTEM (ABMS)

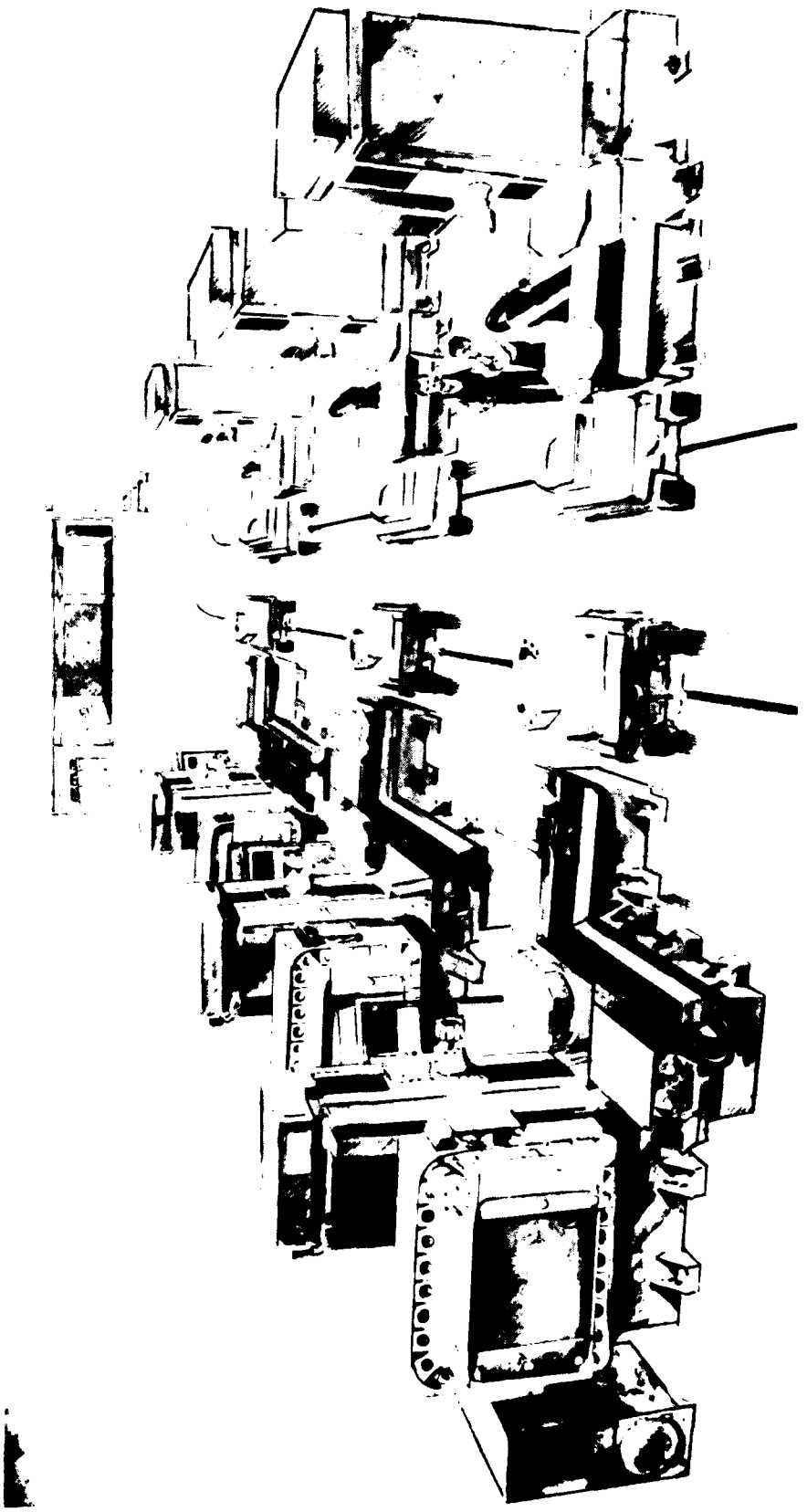


CHART NO. 17-A

PRODUCTIVITY IN MANUFACTURING
MANUFACTURING TECHNOLOGY AND FACILITIES

AUTOMATED BATCH MANUFACTURING SYSTEM (ABMS)

- PRODUCTIVITY ENHANCEMENTS
  - 9 MACHINES VS 25 STANDALONE N/C MACHINES
  - 3 OPERATORS VS 25 OPERATORS
  - 1.5 PERFORMANCE FACTOR VS 4.6
  - 80% UTILIZATION EXPECTED
  - CHANGE FLEXIBILITY
  - IN-LINE PART INSPECTION

CHART NO. 17-B

and much other data are eliminated as being very costly and unnecessary. How will DOD adjust its data requirements to realize these very significant cost savings? How will contractual data requirements be adjusted to the natural output of a computerized system? How will DOD approach the question of second sources?

Second, overhead rates, as traditionally calculated, in an increasingly capital investment environment will become extremely high. The procurement community will have to learn to evaluate production proposals using new kinds of ratios and criteria.

Now, with respect to capital investment, there is nothing magic about achieving the new levels of productivity which an industry must achieve. It has to do with applying new technology to this objective and, as we've seen here and all know, this multiplication of human effectiveness is achieved to the end through whole new levels of capital investment.

There is no way to duck this issue. In the end, capital investment and the incentives for this capital investment are the bedrock of productivity gains. Given those incentives, there is literally nothing that industry cannot and will not achieve. The incentives must come directly from the Government and from DOD: tax policies; accelerated depreciation practices rather than those permitted by our outmoded and archaic practices which have strangled our ability to be making the investments we should be making; improved progress payments to improve the cash flow essential for investment; allowability of interest; stable multi-year procurements; improved profit margins.

With these incentives, our industry will take care of the rest; without them, no amount of rhetoric or urging will achieve the desired goals. As a mentioned earlier, there are encouraging signs that these factors are at last being understood and hopefully acted on. In our own case, we are betting on this and are betting on the five-year $1 billion investment program to show our faith and show what can be done.

Now I could talk about naming other factors which, from the defense industry point of view will be important -- the transition from development to production and how it is handled by DOD and industry; the supplier base and its importance particularly with the disaffection of second and third tier suppliers in recent years with defense business, and the importance of timely availability of parts for efficient production; the opportunities for productivity which exist in software design which, as computer technology evolves, will become the principal stumbling block in developing and producing our systems.

But rather than these, I'd like to mention for a moment the single factor which, along with capital investment, lies at the heart of major advances in productivity in our industry -- and that is the human factor part of the equation -- people.

Certainly a highly motivated labor force is central to Japan's success.

The correcting of mistakes requires an enormous fraction of a plant's productive capacity -- the repair of defects and retesting. This is particularly true in the complex products of our industry. So emphasis on quality, on training, on motivation of people has a huge impact on costs, i.e., on productivity.

Much has been done in the last few years in this respect; much more is possible. We have all found that our workers are capable, intelligent; they want to do a good job and they can help enormously if given the opportunity to participate, as many of us have discovered in our experiments with Quality Circles or similar groups.

In our own case, we have had amazing results -- grievances way down, valuable cost-saving contributions, a new sense of esprit, or participation and "psychological ownership" of our products. There is no reason at all why we can't achieve a new quality culture of our own.

(Chart number 18) But in the end, this is our future - the young people who are coming up, both professionals and non-professionals. Comfortable with the computer culture - laid back, perhaps with somewhat different values, but we have found that they are better prepared, if anything, than we were and just as interested and motivated in doing a good job in challenging assignments. They are less patient with their leaders, perhaps, than we were. But that's a good sign. When we're talking about major advances in productivity in the future, we're talking about these people supported, as you can see, by heavy capital investment.

In conclusion, our nation - the most innovative, productive, highest standard of living society in history - promises to be seriously eclipsed by the end of this decade unless we recapture the factors which made us great.

FACES OF THE FUTURE

CHART NO. 18

This is being recognized now and change is in the air. It can make a far-reaching impact in the defense sector, perhaps even an historically crucial turning point. Certainly it represents a major challenge to the leadership of DOD.

In all this, let me leave you with a plea that a new "productivity cult" not be formed. Productivity is the prime business of all of us from top management on down, and as long as we keep it that way - maintain the focus and will and action - we'll succeed.

Thank you.

Dr. Simecka

Since we're running ahead of schedule, Dr. Currie has agreed to take questions now.

Question

Will the Vu-Graphs be reproduced in the proceedings?

Dr. Currie

Yes, I will make them available.

Question

How effective are the Quality Circles in the manufacturing programs?

Dr. Currie

We have been getting into it in our company in recent years and as I mentioned, we have had some amazing results. I think part of the affect of these Quality Circles has been to focus the interest of top management and also first-line supervision, where much of the action has to go, on what some of the real problems have been in the past. You know, you get so busy doing things that you lose track of the human content of what you're doing - the people aspect of it. So we found that it has tremendously stimulated first- and

second-line supervision on up to top management, including the President of our company, who goes around and takes part in reviewing these Quality Circles and meeting with the people. Right now, we have about 200 Quality Circles in our company, actively going, and this has built up slowly so that we could get some real experience and find out that they really are important. At the end of 1982, we will have about 400 in operation. Now, this is right across the company. It embraces not only the manufacturing operations, but we have very similar activities in engineering, in procurement, all of the functions of the company.

Question

How are the Quality Circles in engineering?

Dr. Currie

In engineering, the Quality Circles really have not embraced the professional engineers, as such. But there are many functions in engineering which are covered; for example, people in prototype shops, people at the technician level. These are getting underway and proving pretty valuable. We are getting all sorts of ideas. These people are very innovative and all you have to do is ask them. It's very important to follow up, though, and give them feedback. You just can't assimilate all this without making a management commitment to following up on their suggestions, meeting with them, and so forth. This is what gets it going and probably the most important factor of all, which we found, and I'm sure you all have, who are taking part in these Quality Circles or similar activities, is the quality of leadership and the training ahead of time that you provide for the leaders of these activities.

Question

How frequently do your QCs meet, how long do they meet?

Dr. Currie

They meet for various lengths of time. I think they determine how long they meet. Some of them meet for many months, as long as they are productive and the group feels they are accomplishing something. Some of them feel that they reach their objectives fairly shortly, in a matter of maybe a couple of months. The frequency of meeting - once a week, once every couple of weeks.

Question

To what account do you charge the labor?

Dr. Currie

We charge it to cross-over. It's an overhead expense. Many of them meet on their own time.

Question

Do you have a monetary reward program?

Dr. Currie

No, we do not. I am not sure such an award program is appropriate for Quality Circles. It seems to me that it would contradict many of the objectives. We have other kinds of programs for professionals and non-professionals. Some involve monetary awards, but not the Quality Circles.

Question

In the rapidly changing CADCAM environment, how far can you plan ahead?

Dr. Currie

We plan ahead five years. We have a five-year capital investment program updated annually and we try to project what things will come about in this field over the next several years and create a clexible enough system to incorporate them. There are many changes along the way, but to answer your question specifically, it is a five-year plan. You have to commit to something like that to really fundamentally get started to begin with.

Question

Are your Government overhead monitors bothered by your billion dollar capital investment program?

Dr. Currie

Some of them are; some of them fundamentally don't understand what it is all about, and it increases overhead, as I mentioned. It is a big expense to a corporation. It should be a greater expense. We should write off most of this capital equipment in two or three years, rather than ten years plus. I hope it becomes a greater problem to the government people so that they will have to come to grips with it.

Question

Many people feel that one reason for loss of productivity is due to the demands of the financial community for short-term results. How do we embark upon a longer-range program and get this accepted by stockholders in the private sector?

Dr. Currie

I don't think our decline in productivity is due to the demand for short-term results at all. It is due to the inability to make capital investments and get a return on that investment. The prime rate right now sits at about 20 percent, so borrowing is between 18 and 22 percent for a corporation. That's an enormous amount of money. With our government contracts, DOD contracts, at least until very recently, they have all been on 80 percent progress payments. Now, when the Government is making 80 percent progress payments on the work, that means that superficially, you are investing 20 percent in all of the work in process. Actually, that 20 percent is more like 35 to 45 percent, for a typical company, when you put in the payment lags, the real business lags in the system. So, as one example, the Defense sector is financing, let's say, 35 to 45 percent right now of all of the work in process with money that we have to pay 20 percent plus or minus interest on. Now that 80 percent progress payment was created in 1969, at a time when inflation was at 4 percent, at a time when the prime rate was 6 percent. It's totally outmoded. DOD is beginning to understand this now. In the last 10 months or so, we - Industry - have been working with the Government to create computer models of how a real business operates, and DOD has now acknowledged that this is the case. They have now come out with a directive in the recent past to increase progress payments from 80 to 85 percent, and they are experimenting with flexible progress payments. Each one of the services is picking a few programs. In my own case, it's the M-54-C, the Improved Phoenix Missile, which will go on a flexible progress payment program under Admiral Whittle, which will ensure that our investment is not over 5 percent. Now that frees up capital, cash flow, to put into capital investment. You know, there's no magic in all of this. The money has to come from some place. So I don't think it's the demands of the financial community for short-term results, although I guess in part it's that, but it's basically the existence of archaic accounting rules in this country, archaic depreciation rules. For example, in Japan, you can depreciate capital equipment 50 percent in the first year. Here, we depreciate over 10 years. Now, let me give you a concrete example and run through it here. Let's say I paid $1,000 for a piece of capital equipment. To replace that piece of equipment, this machine tool, let's say, at an inflation of 15 percent - that's an easy number to deal with - that means every 5 years the cost

of replacing that piece of equipment is doubled. So, in five years, instead of spending $1,000 for that tool, it costs $2,000, and in 10 years, it would cost $4,000 to replace that tool. In the meantime, I've taken that $1,000 and written it off over the 10 years, that is, put it in my cost of doing business, which our accounting rules allow, so at the end of 10 years, I'm faced with the job of replacing that piece of equipment for $4,000 and I've only generated, in terms of cash flow, $1,000 to be able to replace. Now, where has the other $3,000 gone? Actually, it's gone in overstated profits. Our country has been caught up in this vicious cycle in which the profits of every major corporation are overstated tremendously and the tax to the Government has been overpaid tremendously. This has left Industry with the inability to regenerate itself from a capital investment point of view.

(The remainder of the questions and answers portion was not recorded.)

John C. Mason

Admiral Whittle, Dr. Simecka, Dr. Tweeddale, ladies and gentlemen; thank you for the opportunity to speak for Bath Iron Works Corporation, and in behalf of the U.S. shipbuilding industry, on the timely and critically important subject of productivity improvement. In my brief remarks this morning, I hope to provide reassurance that we at BIW, and indeed many of our shipbuilding colleagues throughout the country, have been and will continue to be committed to what we proudly consider to be exemplary productivity improvement programs.

Before I summarize these programs, however, and particularly for those who may not be familiar with Bath Iron Works, I would like to briefly highlight our current activities. The present business backlog at BIW is at a peacetime record of $757 million, which includes:

- Orders for a total of 18 FFG-7 class ships, of which 7 have been delivered
- Construction of a hopper dredger for the U.S. Army Corps of Engineers
- Construction of a 643 foot oceangoing barge for the California and Hawaiian Sugar Company
- Construction of two 34,500 dwt., diesel-powered tankers for the Falcon I Sea Transport Company

In addition to naval and commercial new construction, the shipyard is actively involved in overhaul and repair, as well as the manufacture of diversified industrial products.

Since 1975, every Navy and commercial vessel contracted at BIW has been delivered ahead of schedule and under budget. Specifically, the first six production FFG-7 class ships to date have been delivered a total of 80 weeks early and a total of #37 million under budget. The containership MAUI was delivered to Matson Navigation in 1978 five weeks ahead of schedule, and the SS ARGONAUT and SS RESOLUTE for Farrell Lines, Inc., 16 weeks and 13 weeks early respectively.

Why have we at BIW been able to achieve such significant bottom line success in a period when cost overruns and schedule slippages have been far too commonplace? The simple answer is productivity and effective management.

For nearly a decade now, the 300 years of shipbuilding tradition in Bath, and one of the most productive work forces in the world, has been complemented by a management team which has been recognized as leading the industry in productivity emphasis and results. Key elements of this approach include: (1) top level management support and involvement, (2) careful

planning and utilization of available resources, (3) effective integration/ coordination with industry-wide programs, and (4) the participle involvement of the entire work force.

To provide some specific examples of the various productivity improvement programs at Bath Iron Works, I will be referring to three principal areas: (1) internal programs, (2) cooperative efforts with the U.S. Navy, (3) Maritime Administration sponsored programs. It should be re-emphasized, however, that all of these programs have been coordinated to the extent that they form a single integrated thrust toward productivity improvement based on priorities derived from such sources as BIW long-range plans, the Maritime Administration report entitled, "Technology Survey of Major U.S. Shipyards, 1978," and the Naval Sea Systems Command sponsored "FFG Cost Driver Study" of 1977.

Within the shipyard, prime consideration has been the most effective utilization of capital and other resources (e.g., industrial engineering staff) to implement improvements in selected, high cost areas. Major improvements have been achieved in such areas as steelwork production through the introduction of more automatic/semi-automatic welding processes; and in outfit shops such as the Pipe Shop, where a new N/C 2-D bender has been installed. Additional productivity has resulted from improved layout and material flow in areas including the Pipe Shop, Sheetmetal Shop, and Fabrication Shop, and from such innovative projects as the highly efficient cable reel storage/retrieval system developed by BIW industrial engineers.

As documented by the Maritime Administration sponsored technology survey referenced earlier, BIW has recognized that many cost/time saving opportunities are organization and systems related, often requiring little or no capital investment to implement. One area where Bath has become a clear industry leader is the pre-outfitting technique where efficiencies of three or four to one are achieved through installing components such as machinery, piping, cable, ventilation, etc., in the shop early in the hull block construction process. This and other aspects of careful planning, scheduling, and control minimize the amount of work done on board the ship, either on the building ways or after launch, saving thousands of man-hours and weeks of time.

With the continuing support of our parent, Congoleum Corporation, BIW has entered the decade of the 80's by implementing an ongoing series of major productive capacity improvement programs. Last year a major rebuild was completed in-house on our 8,000 ton floating drydock, and projects now in process include further expansion of the existing 100,000 square foot main assembly and pre-outfit building to include an automated flat panel production line, and the construction of a new, integrated shot blast and paint facility.

In several key areas, Bath Iron Works has joined forces with the U.S. Navy for what we certainly consider to be necessary and exemplary, cooperative approaches to productivity improvement.

First, as the lead builder for the FGG-7 guided missile frigate program, BIW participated with the Navy beginning with preliminary design to optimize producibility of the ship. This approach, augmented by innovative contracting and series ship procurement, has provided Bath Iron Works with the opportunity to implement significant productivity improvements, and has provided the Navy with one of the most effect effective and successful shipbuilding programs in history. These areas, as well as ancillary programs such as centralized configuration management and major component procurement, must be even further exploited in the future.

Secondly, BIW has led the shipbuilding industry in supporting the U.S. Navy Manufacturing Technology program. The intent of this program is to translate emerging technology from the lab or drawing board to an actual production application. At Bath we have approached this program seriously by searching for projects which will satisfy three basic criteria. Number one, the project must make an integral contribution to an already identified, priority productivity improvement area. Secondly, the project must truly represent the application of new technology for a major improvement in the manufacturing process. Finally, the end product must be generic and cost-effective to achieve the Navy's ultimate objective of technology transfer throughout the industry.

At the present time we are nearing completion of the first of such programs, which is the development of a Computerized Numerically Controlled Sheetmetal Component Fabrication System. This project, a portion of which has already been implemented on FFG production, marries interactive graphic part development with an N/C turret punch press/plasma burning machine, resulting in a 40 percent reduction in direct man-hours required to define and produce ventilation and flatwork (bunks, lockers, etc.) component parts. Shortly, we anticipate signing a second contract with the Navy involving the application of industrial robotics for plasma cutting and marking, which will provide an estimated 50 to 60 percent reduction in man-hours in another highly labor intensive area.

These programs are particularly important since they complement that which we can do with our own available resources; they provide funding for areas representing higher levels of developmental risk than usual business/financial criteria will permit; and, as with all productivity improvement programs, they result in significantly increased manufacturing capacity within existing facility constraints as a normal by-product.

The third major area comprising an important element of Bath Iron Works' productivity improvement programs is our participation in MarAd sponsored R&D programs.

This program, which is maintained with minimal funding from MarAd ($2 to 3 million per year), and administered/cost-shared with the industry through the Ship Production Committee of the Society of Naval Architects and Marine Engineers (SNAME), addresses improvements in such areas as facilities, coatings, outfitting and production aids, standardization, industrial engineering, computer aids, engineering/production integration, and education. Some 23 shipyards actively participate in the program through the various technical panels on a voluntary basis. The bottom line results of this effort are significant, e.g., a 20 to 1 return on investment in such areas as welding, and the cooperative approach to industry-wide productivity has been hailed by others such as the General Accounting Office and representatives of the automotive industry as being a truly unique and exemplary program.

Since 1973, Bath Iron Works has sponsored a principal component of this program on Ship Producibility, and in the past four years has been proud to lead the way to two major industry-wide initiatives: (1) standardization, and (2) industrial engineering.

Nineteen shipyards, as well as the Navy and MarAd, participate on the SNAME Standards and Specifications Panel chaired by BIW; and more than 175 voluntary industry representatives are participating in the new Shipbuilding Committee of the American Society for Testing and Materials (ASTM). Approximately 70 new cost and time saving standards are now being developed (with many already implemented on new contracts), and the U.S. Navy is actively involved pursuant to OMB Circular A-119 of January 15, 1980, which establishes policy for government utilization of commercial standards in lieu of costly MIL-FED specs or standards.

The standardization program, while recognized as a long-term proposition, is already making a significant contribution to shipbuilding productivity. In addition to the production man-hours and material dollars saved, standards impact two particularly critical areas: (1) standard practices, specifications, test methods, etc., will significantly improve productivity in production support, specifically in engineering and procurement. Less time need be spent on repetitive, routine requirements, both accelerating the process and permitting allocation of key human resources to priority areas such as producibility, earlier definition of technical data, etc., and (2) standards extend beyond the scope of shipyard control to the major equipment suppliers for improved availability of essential components and material at a reduced cost. On Monday and Tuesday of this week, the ASTM Shipbuilding Committee, in

close cooperation with the Navy, sponsored a workshop involving more than 100 representatives of shipbuilding equipment suppliers addressing this very issue.

The shipbuilding industrial engineering program, also chaired and managed by BIW, represents an aggressive thrust by 18 participating shipyards, in cooperation with the American Institute of Industrial Engineers (AIIE), to apply basic I.E. techniques to shipbuilding. Primary emphasis has been placed on methods engineering with extremely significant results. In one shipyard's study, methods improvements on essentially duplicate ships built five years apart reduced direct labor hours 12 percent in structural trades and 11 percent in piping, electrical and coating trades. These savings equated to 90,000 man-hours per ship at a rate of $20 per hour, or $1.8 million per ship. Such improvements are ongoing and cumulative, reduce total cycle time as well as saving labor and material dollars, and will be further augmented by follow-on programs already planned for the immediate future.

In addition to these direct benefits at Bath Iron Works and other participating shipyards, the MarAd sponsored R&D programs function as a catalyst for related individual shipyard initiatives. During the past one to two years, emphasis on such programs has been accelerating. Advanced Technology programs funded by individual shipbuilders, e.g., at BIW and the Avondale Shipyards Japanese technology transfer program, are estimated to represent a total investment of $3 to $4 million per year across the industry. MarAd funding is used to integrate the individual efforts and to develop areas of common interest and application.

It is anticipated that this essential element of shipyard productivity improvement programs will play an even more important role in the future through industry participation in the recently-incorporated IREAPS organization (Institute for Research in Engineering and Automation for Productivity in Shipbuilding), particularly if funding support for this nonprofit productivity institute is forthcoming from sources other than the shipyards and Maritime Administration, e.g., the U.S. Navy, National Research Council, etc.

In summary, for productivity improvement programs to be really successful, we must all join forces for a coordinated "team" approach. That is why conferences such as this one sponsored by the American Defense Preparedness Association and the U.S. Navy are so important, but still not as critical as what happens after the conference adjourns. The environment for tremendous productivity improvement in the shipbuilding industry has never been more positive than it is today. Shipyards like BIW are doing everything possible within existing resources to provide cost-effective ships to the Navy and commercial owners, with the ultimate goal of becoming once again

competitive in the world shipbuilding marketplace. To be successful, and to accelerate necessary improvements, our industry needs effective support.

Principal areas where significant opportunities now exist include:

(1) Integration of Productivity Improvement Programs with Procurement Policy - ample precedent exists for approaches such as those mentioned earlier for the FFG-7 program, the General Dynamics/U. S. Air Force F-16 TECHMOD program, multi-year contracting, increased incentives for independent research and development (IR&D), etc.

(2) Expanded Navy Manufacturing Technology and Shipbuilding R&D Support - While the Army and Air Force have sponsored major components of the DOD MANTECH programs for the past decade) with extremely effective results), the Navy program has been weak. BIW has literally invested thousands of man-hours of key talent supporting this program for the past four years, and I am pleased to say that in the past one or two years, we have found a few concerned, sympathetic ears, and the Navy M.T. program planning calls for significant expansion beginning in fiscal year 1982. We strongly support this renewed emphasis for reasons stated earlier in this presentation.

Related to an expanded Manufacturing Technology program, it is also our understanding that a major new shipbuilding technology initiative is being planned within the Naval Sea Systems Command. Again, we strongly support this action, but with one significant comment. While there is a normal tendency to want to "start fresh" with a new program, now is not the time. As summarized moments ago, individual yards and the various industry groups have defined programs, priorities, and key people already in place through established productivity improvement programs. This existing structure should be used to the maximum extent possible. It is again encouraging to note recent Navy indications that this initiative will be closely coordinated with ongoing efforts, including significant funding input in FY-82.

(3) Effective National Maritime Policy - Maritime Administration programs such as CDS (Construction Differential Subsidy), Title XI Loan Guarantee, and Shipbuilding R&D are all currently under threat of severe curtailment due to the lack of an effective national maritime policy. As indicated earlier, MarAd sponsored shipbuilding R&D programs are an essential element of the industry's total productivity improvement thrust. Knowledgeable individuals recognize that only by increasing productivity can U.S. shipbuilding truly become more competitive in the world market, thereby minimizing or eliminating the need for subsidy.

In conclusion, through this brief summary I am sure that you would agree that we at Bath Iron Works Corporation, and many of our shipbuilding counterparts, are addressing productivity improvement as a priority management issue. Improved productivity is the best answer to the nation's ability to respond to the challenges of a rapid turn-around in our national defense posture and to the revitalization of our ailing economy.

Thank you very much.

Dr. John DeCaire
(Introduction and beginning of presentation not recorded)

wiring assembly area, basically it's all manual with people sitting at benches, what we call a process ownership area. Typically, you would have the various crafts or specialties mixed and integrated around on the factory floor, but what we did was rearrange the entire assembly area to provide people of like function in the same place and to give them that feeling of ownership of their area and charge them with housekeeping, preventive maintenance, and all kinds of activity associated with their particular area. Then we dressed that area up by basically applying open office type of furniture activities. These were all just open pools before, now you see they are separated into two- and multi-person modules with a sense of territorial imperative, if you like. This shows you the assembly area, again dressed up with various types of activity - still largely, though, operators sitting at benches, all performing like functions and having some sense of element. We then decided we had to start to measure the yield and we did not have any automated approaches available at that point, but we started by basically manual data collection yield and then targeted the development project to come up with a computerized system. Of course, we wanted to add measurement points earlier in the process and these are the gates which we finally identified. Again, remember, we are tracking. We allow no rework internal to any of these process steps. The operators do it, when they pass it out it's determined that it's good, if it has to go back it's not counted as good yield. As you can see, we asked them to manually catalog the faults that went with these activities. In terms of the

In terms of the automated system, we looked at building up a barcode reader using basically a magnetic wand to read barcode and this has really two objectives; one to automate the measurement process and keep track of the work as it flows so it is a production control tool, but it also now gets our production operators involved interactively with a terminal, which is eventually in the long term the kind of environment we would expect to have overall throughout the production environment. We prepare menus which list the various defects and the operator just keys it in to the computer and, of course, the computer analyzes the information for yield activities.

Let me comment on what the results of all this have been. This was put in place approximately December of last year with all these activities occurring in that period of time. I mentioned the figure of 12 that we thought was a composite the first time through yield. It turned out we were actually a little bit lower than that in terms of at least the first hard data that we began to achieve. I might just comment that we have now, since December, increased that first time yield by approximately 40 percentage points just by virtue of what we have done here and a 20 percent increase in individual operator productivity. We are systaining more product with fewer people and a higher quality product, as well.

We synergized this activity overall with what we call strategic robotic system development and particularly I mentioned the parts

material handling issue. We have a project which we call MARK in the Defense acronym environment standing for Material Accountability and Robotic kitting and conceptually it looks something like this - basically a single operator sitting at a console with computerized data base of what materials are in store, using robots to do the picking and so forth in response to an order pick, and also then delivering that to a second robotic system which would go through the lead preparation component preparation actual kitting operations feeding a transporter which goes out to the individual assembly areas. The printed wiring board assembly - we anticipate a common robotic manufacturing system for that which we call the Seize Station.

From that MARK station that I showed previously, you see the parts coming from the background center. We have a series of automated robot systems and various hard automation systems which actually go through the loading of the components, the preparation, positioning of the components, the insertion, the soldering, the automated testing, and it's all under the control of a single operator sitting at the computer console. That is what we have defined as the term "Job Enlargement." There were approximately 8 to 10 different operators of different skills in that whole cycle and now all those functions are now under the cognizance of that single operator who acts as the manufacturing manager for that individual commodity area. He also has vertical changes in responsibility associated with preventive maintenance, general housekeeping of that area and so forth. That common theme is dominating our advanced thinking. This is ongoing in the lab, which is the robotic, very flexible automated type of insertion activity we are pursuing. There are vision systems and here we are using cooperative with Carnegie-Mellon University, for example, through a Westinghouse/Carnegie-Mellon agreement working on tactile force and advanced vision processing to go with robotics. Our productivity center in Pittsburgh is working on advanced robot techniques for doing these kinds of activities and, of course, we are applying them at Baltimore.

In general, that whole activity is now targeted for what we have announced as major investment products of implementing a printed wiring board manufacturing plant in Melbourne, Florida. That is one activity which we are targeted for which should be up and operating about 1982, and similarly we are building an assembly plant in Brian College Station, Texas, which will accommodate the printed wiring assembly activities in these advanced robotic manufacturing approaches.

That is generally how we have targeted very short-term and long-term strategic elements around one particular target area of printed wiring boards and printed wiring assembly. Generally, across the entire product line we are attacking our other product element groups in a similar fashion and it is not strictly an advanced strategic organization as my manufacturing systems and technology organization, but we are using both the functional manufacturing and engineering teams as well as specifically assembled teams cooperatively of engineering and manufacturing to address

all of these approaches in strategy and these show you the other commodity groups that we are addressing in terms of a very similar total process yield and automated assembly kinds of approaches in the long term. Potentially, there could eventually be small dedicated manufacturing types, either satellite plants or perhaps rearrangement of our current plants targeted around these individual elements.

To stress what I said about critical ingredients - the design, materials and processes - important is the coupling of those and in particular, typically we have three generally automated systems which tackle those. The computerated design system was described earlier. In terms of a factory process system, these are the shop floor process development activities. Of course, the business system is nothing more than the material planning and material acquisition and production control aspects of the problem and in essence, we are putting in here a closed loop MRP material resources planning system, eventually to get, as I said, an integrated activity. That is all under the banner of what we call the Westinghouse Integrated Computerated Management Program and it's just an umbrella program directed at the application of automation totally across the board. The percentages you see here represent generally where we feel we are in terms of progress relative to our eventual target goals in automation of these areas. In particular, there is a very large percentage of automated tests and typically that has been the result of our concentration there and our concentration of investment on the back end of the process, and we're nearly there. Of course, the product business base keeps changing so the base keeps shifting also.

In terms of computerated manufacturing and computerated design, we are starting to improve rapidly and in white collar productivity areas we are just getting started but are getting totally off the board there and that is where the major activity is. But in terms of our integrated system, we are going with a common data base, but structured in length, not necessarily resident all in one place, trying to integrate the user community and bring them along in a leadership role as we implement the target. Everything is intended to be interactive. If one takes a user perspective to that activity, all one is really interested in is the information. Certainly, the various functions in planning get started and they build their portion of the data base according to the software programs and the computer resources that we have. When planning is complete, a second function - purchasing, in this case - has access to that data base and builds its portion of the data base and does its function. Similarly, when manufacturing is complete, presumably management has been doing that and we all know that that job is never complete.

From a system point of view, we would go back to the diagram which shows that certainly we have an engineering design system with a design data base activity, interactive graphics being a key input to that, manufacturing process data base on the bottom, again manufacturing engineers through interactive graphics - that is all integrated with what we call a process planning system, which is really

nothing more than group technology classification and coding of the product, of the processes, of the equipments, and we interface that with cost estimating and work measurement approaches and in essence, with the software programs and the computer resources to make all of that operative, what you have in place is the design to cost trade-off system without ever having really to build a product. It can all be done through data analysis and knowing capabilities, at least so far as the data base is accurate.

Overall, from a Westinghouse point of view these general approaches, the overall quality umbrella, the overall combined advanced technology and integrated data base activities is being systematized through a corporate productivity center. We have a Vice President of Productivity and we have a productivity center established near the Pittsburgh airport and in essence concerns five major divisions: an Advanced Manufacturing Technology Division, which is basically shop floor process automation (and you're going to hear about that tomorrow from Tony Massaro, who heads that Division; in the Data Processing Systems area, we have the Corporate Systems Integration Activity; we have Production Methods and Measurement, which deals with general industrial engineering and manufacturing engineering activities; we have a Corporate Quality activity associated with quality circles, quality college, and that general issue and of course Value and Operations Analysis. These groups will systematize that application and cross-fertilization of advanced productivity quality technologies throughout the Westinghouse Corporation.

In terms of the future, I wanted to close with a particular element. This is what we would view in the future in terms of management of the factory, and this is our Associate Group Vice President of Operations working on the terminal in his office looking at our resource planning and business projected system. I question whether that will be the future or whether it will be something else where perhaps the efficiency of management is sufficient that we don't need all of the typical management. One wonders whether American management will be really ready to step up to what the true issue might be at that point.

So with that thought I will entertain any questions. Thank you.

Q: In the Management Information System, it appears that you have a distributive process and not necessarily a consolidated data base.

Dr. DeCairo

It is a structured-in-length data base. It is communicating data bases. The data base is common in the sense of the information it contains, but it is distributed in terms of implementation and we are structuring and linking it accordingly. Our Computerated Design System is based on a Sperry Univac main frame computer. Our Business System, MRP System, is being implemented on an IBM type of computer, and the Shop Floor Process has, I think, one of

every computer in it. We seem to be concentrating largely on Hewlet-Packard and IBM in the mini-computer/micro-computer areas. The Shop Track System that I mentioned, in terms of yield measurement, is one of the first modules of that integrated MIS system that we put out on the factory floor.

Q: Is this general through Westinghouse?

Dr. DeCaire

What I have described particularly is the program that we are implementing at the Defense Center, but the general approach is an activity of robotics and increased yield measurement, and this is being applied throughout the Corporation.

Q: Is this program individually controlled at Westinghouse?

Dr. DeCaire

Each Division, of course, generates their own program, but it is cross-fertilized entirely through the corporate Productivity Center for elimination of duplication and the like.

Q: What success have you had in getting your vendors to increase their reliability such that you might reduce testing?

Dr. DeCaire

We haven't really gotten into implementation to a very strong degree yet that activity. Right now our concentration is in assessing just what quality level are we getting from those vendors. I would note that people like Texas Instruments have recently announced just based on their own competitive business environment quality improvement targets of .01, so we anticipate that that is going not to be very difficult.

SESSION II

ORGANIZATIONAL DEVELOPMENT

Dr. Simecka

Session II is entitled Organizational Development and our session chairman is Dr. Frank Shipper, Productivity Management Office, Naval Material Command.

Dr. Shipper is an Assistant Professor of Management in the College of Business Administration at Arizona State University. In 1980, he was selected as an American Assembly of Collegiate School of Business Federal Faculty Fellow and is currently working for the Naval Material Command's Productivity Management Office. Dr. Shipper received his Bachelor's Degree in Mechanical Engineering from West Virginia University in 1968, his Masters in Business Administration from the University of Utah in 1973, and his Doctorate of Philosophy in Business Administration with specialization in Organizational Behavior and Research Methodology in Statistics from the University of Utah in 1978.

His business experience includes work in biomechanical research and materials engineering. At Arizona State he teaches both graduate and undergraduate courses in organizational behavior, business policies, and management. He is also an instructor at Center for Executive Development doing both public offerings and . . . programs. In addition, he was one of the co-founders of the Data Base Organizational Research Group. It gives me a great deal of pleasure to introduce to you Dr. Frank Shipper.

Dr. Shipper

Thank you for the introduction. It's a pleasure to be here. At Arizona State University, where I teach most of my life for the last four years, they give me the 7:40 in the morning group and the after-lunch bunch. I see I have the after-lunch bunch here.

A lot of people sometimes wonder what organizational development is about. Sometimes I wonder myself what organizational development is about. But I think sometimes it is easier to describe what organizational development is about rather than to try to give you an empirical or theoretical definition. At the Naval Material Headquarters, we have a productivity improvement program going currently and we are aiming it at the staff level. We aim a lot of things at the production level, quality circles job enrichment, and so forth, but we have a productivity improvement program going at the staff level based on a team approach. On making up the team, we were able to select various individuals for this team. I selected a few well-motivated, key individuals, very knowledgeable in the area and we also placed in the group a couple of individuals who were not too motivated. We thought we could turn them on. One individual in particular came in for some remarks from his superior. This individual was described to me as lazy, unmotivated, late to work, sleeps at his desk, and other less complimentary

descriptions - descriptions that I could not repeat in front of ladies. During the period that this team has been together, this same individual who was described in that manner has been the most productive individual in the entire team. He has turned in the most ideas, he has documented the most ideas, and I found out in a conversation in the hallway, that this same individual works on pre-1940 aircraft. He maintains, flies, test flies, and even rebuilds pre-World War II aircraft. That to me is a lazy, unmotivated worker and yet we have some ways that we can turn him on. That's what we're going to be talking about this afternoon and we'll start off by talking about impediments to productivity and a lot of them are in the white collar environment. The white collar environment today makes up 70 percent of the entire environment that we deal with.

The impediments that we'll start with will be presented by Robert A. Sniffen. Bob Sniffen started as a Research Analyst with the Department of Mental Hygiene for the State of California. He saw the light. He joined the Navy. He worked with the NPRDC, the Navy Personnel Research and Development Center out of San Diego as a Field Researcher and I would say a Field Implementer, not just a researcher, for 13 years. Recently, during the past year, he has joined the Headquarters, Naval Material Command productivity staff. It has been my pleasure to work with him. They have two major programs. One is called the Impediments Study and the other is called the Performance Based Incentive System. Both programs have been able to produce significant results in less than a year. Without further introduction I am going to turn the microphone over to Bob Sniffen.

Mr. Sniffen

Good afternoon. Thank you, Frank.

We have met the enemy and the enemy is us. These words belong to the well-known cartoon character, Pogo, and seem particularly appropriate to the subject of my presentation today.

In a study conducted last year by the Navy Personnel Research and Development Center for the Chief of Navy Material, it was found that productivity at the Navy's industrial activities was suffering from some self-inflicted wounds not unlike those being reported in some segments of the private sector. One example of these wounds is that of micro-management, a particularly pervasive form of excessive organizational control. This was just one of the findings reported by NPRDC in a study of productivity impediments in the Navy. Fortunately, many of the impediments found are treatable and even more importantly, they are preventable to some extent.

Before going into the specific findings of the study, I would like to correct any impression that you may have or may get from this presentation that the Navy is uniquely plagued by productivity problems and is devoid of any productivity enhancement program or

initiatives. On the contrary, the Navy has a very aggressive program of productivity enhancement and is a leader within the Department of Defense and the Federal Government as a whole in this area. As Admiral Whittle correctly observed when he directed that this study be conducted, identifying and removing impediments to productivity can lead not only to productivity improvement in and of itself, but can also create a favorable climate for implementing productivity enhancement initiatives.

The objectives of the study were to identify the impediments themselves. What were the impediments? To trace the sources of these impediments, that is, at what level did the impediments originate and what were the immediate and root causes of these impediments. And finally, to report the findings back to management and in particular, to Admiral Whittle in an unfiltered fashion.

Major steps in the study included joining forces with the Office of Personnel Management. They were interested in conducting a similar study in the personnel area, so Navy Personnel R & D Center and Western Region OPM got together and formed a team. They went out to the field activities and collected the information. They first contacted each one of the Systems Commands, informed them of what they intended to do, asked them for recommendations about where they should look for impediments in the field activities. This also keep Headquarters in the loop in the study, instead of bypassing them.

They formed five teams and went to five different types of activities; a shipyard, a weapons station, a naval air rework facility, a public works center, and a supply center. There was a search for documentation and confirmation. Since there were so many issues, they decided to group the issues into those that could be controlled locally and those that were beyond local control. They contacted outside sources for those impediments identified as beyond local control. Finally, they went to similar activities to verify the findings from the original activities. Lastly, they fed the information back to management, not only headquarters management but the local management, along with recommendations.

The methods used in collecting these data included individual interviews at the headquarters and field offices in one-on-one and structured interviews. They also conducted a structured brainstorming session with management at the field activities. They cut through all levels of management at the activities in conducting these sessions. Finally, they issued questionnaires to a random sample of non-supervisory and supervisory personnel.

The findings I will group into two major categories; the non-personnel issues and the personnel issues.

There was a question at lunchtime that was raised as to what is micro-management. I guess micro-management is really in the eye of the beholder. A field activity would certainly have - and certainly has - a different view of what constitutes micro-management

than does the headquarters. But essentially, it consists of things like restricted autonomy for subordinates in the chain, not delegating sufficient authority downward, and having responsibility at those lower levels without the concomitant authority necessary to carry out the responsibility.

Some examples: excessive inspections and audits. This was raised at the field level. They felt that there were redundant requests coming from inside and outside the organization for information that might better have been collected under fewer audits. These inspections and audits also lacked coordination. It resulted in excessive paperwork and work interruptions at the field level. Buying and spending limits. It was felt by many of the field activities that the buying and spending limits were too low, especially in view of the inflationary situation that the limits needed to be raised. Proliferation of instructions. They also felt that there were many, many instructions coming down from different sources and they lacked coordination. Many times these instructions conflicted with each other, overlapped each other. Field activities felt that there could have been significant incorporation and coordination of these instructions. Lack of central coordination - again, the instructions, specific requirements, and demands were coming not only from internal but external sources and these demands were not being coordinated. An overreaction to noncompliance or a failure to practice positive constructive confrontation at the source of the infraction illustrates two problems - a problem of micromanagement and a blanket restriction of replacing positive problem-solving. An example of that would be a blanket instruction being issued because one particular field activity violated one instruction and instead of going directly to that particular violator, there was a blanket instruction issued to all activities which further restricted the other activities.

In the area of supply support, it was found that field activities, to some extent, were unable to obtain material in a timely manner. There were delays in new and ongoing work and this also led to cannibalism of existing parts there for rework also. Requisition tracking was found to be much too slow. They were doing it in a batch mode, rather than in an interactive mode. In material acquisition, it was found that there were many, many wrong parts, lost parts. It was felt that at the field activity level there needed to be greater decentralization and control, and to give to the local activities flexibility in acquiring some of their parts. In substitution of wrong parts, inadequate information on requisitions and lack of training of supply personnel led to many substitutions or wrong parts being delivered. Shortages of parts - field activities felt that they needed authorization to purchase items locally if they were not currently in stock. And the shelf life program, which some of you probably are familiar with, in the Navy they have approximately 16,000 items in the shelf life program, compared to approximately 1,200 in the Air Force, and it is felt that that number of items in the shelf life program is too large and cumbersome.

Inadequate equipment and technology, or an insufficient capital investment problem - that was mentioned earlier and this is an area that has very high potential for productivity improvement, as was also mentioned earlier. Specifically, there is a great deal of obsolete equipment and technology existing in some of the activities today. This is a pervasive problem that leads to frequent breakdowns, the application of more skilled manpower to do the job that might better be done with newer equipment.

Insufficient money for capital investment - it was felt by many organizations that there must be more money made available for capital investment and also there should be a coordination between long-term and short-term planning efforts in the area of capital investment.

The lengthy acquisition process - it takes anywhere from three to twelve years to get some equipment, in the latter case, mostly ADP equipment, into operation in some of these field activities. Some of the problems there are the defense acquisition regulations and the entire process and regulations that go along with it are very extensive. This is particularly true in the case of the ADP hardware and software deficiencies. It seems that less than 2 percent of the Navy's total budget goes to ADP equipment. Of course, the Navy cannot function without that equipment, either from an administrative or an operational point of view. There are over 1,000 computer configurations worldwide. Management of these resources is a very complex issue. There is an amendment that many of you are familiar with - the Brooks Amendment, PL89-306, which is felt by not only the field but by the headquarters as being particularly difficult to work with in terms of acquiring new ADP hardware and software. This is an example, for instance, of micromanagement really from the top, and that particular Brooks Amendment, it is felt, has really not kept up with the changes in technology to make that a workable law.

The lengthy acquisition cycle, similar to the material acquisition cycle - there is extensive justification required, documentation details, some of the regulations lack clarity, and there are changing definitions of what constitutes ADP in the first place. It has been said that some of the costs of documentation actually exceed the cost of the equipment being requested.

A lack of software standards - there seems to be no monetary incentive for the private sector to develop new software for old equipment. There is too much local in-house software modification going on, it was found, and little commonality across activities within functions. Also in this area, it was found that there was a lack of adequate training, particularly of the software users. There is too much specific tailoring going on at a particular activity and very little cross talk between different activities and as a consequence, it is very difficult to train any particular software developer or user in the general principles of developing software across functions.

Erratic work load - there are a number of people here who are familiar with this, who live this problem every day. I don't know how much can be done about this particular problem. It seems the erratic work load is very much a function of the operational priorities, the changes in tempo of fleet operations that seem to be not within the control of the logistics support people, and it is not very easy to anticipate the changes in fleet operations.

Under the area of coordination, it was found that the operational people and the support planners, perhaps, should be talking more to each other and trying to get a better handle on how they can anticipate work load in the future.

Military rotation - there we have a situation of conflicting goals. The goals of the officer's goal and career development versus the goals of the organization in terms of having effective managers in various important positions. Sometimes what results is an inverted U-curve of activity when a new military manager comes onboard; there's a start-up time, a get-familiar time, there's a lull in the activity followed by a period of increased activity and then again, prior to his leaving, sometimes a slowdown in activity. This cycle goes on, as many of you know, fairly frequently and it is rather disruptive sometimes in the field activities. Sometimes military managers who are put into those positions are not familiar with managing what is basically a civilian organization, so they don't necessarily have all of the skills and knowledge necessary to assume that management position. It was found also that there seemed to be an emphasis, at least with the military rotation, on short-run versus long-range goals. If you were a manager going into an organization and you knew that you were going to be there for one or two years or some short period of time, you might be reluctant to take or initiate action that would not show results for four or five or six years or some time in the future, because essentially it wouldn't happen on your watch and you wouldn't get credit for that particular innovation.

In the area of personnel issues, it was found that there were unrealistic ceiling limitations imposed on the activities. These limitations come down from the President, Congress, and are administered through OMB. They are imposed on the field activities and the activity can't do much about that; even though they have enough money to accomplish the work, to hire the people, they are restricted by these ceilings. One of the things that is done in some of the activities to get around this is to release and rehire temporary employees at the end of the fiscal year to avoid having full-time employees on the rolls at that particular time. Unfortunately, this results in not getting the most qualified people and it is very time consuming to rehire all those people that you just released.

Delays in staffing - it seems that this is a critical problem in getting qualified people onboard. There is a lack of qualified

applicants out in the field, anyhow, and when the Navy has to compete with private industry for these qualified people, delays in staffing can hurt them even more. It was found that there was really no tracking system in various personnel offices at field activities. They didn't really know what was happening in that staffing process. There is much duplication in the development of a thing called accrediting plans for merit promotions; that is, supervisors are required, in taking promotion actions, to develop a large portion of accrediting plans that are used as the basis of the promotion action and personnel offices were doing much the same thing. There is much duplication of effort there and a waste of time.

The NACI, the National Agency for Check and Inquiry, is something that all new employees have to go through. It is an inspection of the employee and sometimes this delays the hiring also - either the hiring or the assignment of a person who is qualified to his particular area because they will not be assigned until the investigation is completed.

Supervisory appraisals was another thing that caused a delay in staffing. It was felt by most of the personnel officers that the appraisals are ineffective - they are basically a waste of time on the part of the supervisors in filling them out and also in the selection process. They don't give realistic information.

Pay and position management - a large issue. There is a relatively sensitive issue here of the pay inversion and comparability problem. That is, the Navy competes with private industry and this is a rather purvasive problem of Navy feeling that they in some cases are not competitive with private industry as far as offering the levels that are required to get the qualified people in. Also, there is a comparability problem inhouse between the so-called wage grade employees and the general schedule employees that also creates problems of getting qualified people into the positions.

There seems to be a penalty for practicing good position management in the Navy, or at least that was found in field activities, to some extent. What this might result in if a manager practices good position management while his staff is reduced. His budget might also be reduced. This also might lead to his advancement being held back because unfortunately one of the criteria that seems to be used for advancement is how many people are supervised. There is also a conflict between the goals of management and those of the personnel offices within the field activities. Of course, management is interested in getting the most qualified people, holding on to those qualified people, and there seems to be almost an ongoing battle between management and personnel offices because personnel offices are interested in following the regulations, doing it by the book, and there seems to be a running battle between those two groups.

Limited supervisory effectiveness really has to do with the level of training and background that is brought into, in particular, the first and second line supervisory positions by people who came up through the ranks. They might be excellent technicians, engineers, and they are put into positions of management without really a sound background in management and supervisory techniques.

The administrative requirements were excessive, according to many of the managers and supervisors at the field level. They felt there was excessive paperwork workload.

Also, the Incentive Award Program at the activities was found to be not as effective as it might be. Managers don't seem to be, in some cases, getting the most out of their people through this particular program. Two of the problems that were identified were that there were too many levels of review required for approving an incentive award, all the way from the first line supervisor all the way up to the head of the organization - in these cases, the Commander of the activity. Also, most activities use the committee review approach, where all recommendations are reviewed by a committee.

I guess one of the important things to ask is, now that we have identified the problems, what are we going to do about them? Admiral Whittle directed that a task group be formed and chaired by Doctor Tweeddale of the Productivity Management Office to address these issues. His group was formed and its goals and objectives were to address the issues within NAVMAT control, demonstrate initiative and progress on some of those issues to a higher level because there would be some later attempt to get higher levels to take some action on some of these issues that are beyond local control. Some of the steps that were taken by this group include a verification and classification of the issues. The makeup of that particular task group consists of a representative who speaks for the Command from each of the Systems Commands in Headquarters.

In the verification and classification process, this task group went through those issues to verify that it was a problem and at what level that problem could be addressed. They also selected a subset of issues that could be addressed. They are in the process now of developing a Plan of Action and Milestones designating what action is to be taken, by whom, and when the action would be taken and completed. One of the things that has gone on in these sessions is that there has been some information exchange between various commands. If one command had some program going on, they could exchange that information with the other command and make recommendations or suggestions on how they might use the same approach in relieving that particular impediment.

Now, just because the task group was formed doesn't mean that the activities, the headquarters, have not been addressing these issues on their own. There has been much independent action going

on outside of the task group. For instance, in the area of the issue of lack of parts, they have put together a program where they are attempting to increase the funding, review the material and management system, add additional training for supply-related personnel, procure automatic storage and kitting and retrieval systems to standardize material support functions within the NARFs and to develop new forecasting procedures for anticipating the bits and parts requirements two years hence. They are trying to more clearly define the responsibility and accountability for support within their command. I might add also that in the area of production support at the NARFs, they are realigning their branches and divisions within the production and planning control departments to those in the production department for increased coordination.

There is also a plan for fuller implementation of computerized equipment maintenance management programs at all NARFs to isolate problem areas and identify corrective actions for equipment maintenance. I understand now that they are on a manual basis at both Jacksonville and at Norfolk. The goal is to establish a common system for all NARFs by FY 83.

There is also an ongoing program of attempting to address the short-term capital investment problem through the programs and the fast payback programs. Some spending limits at the field activities have been raised. There is an effort going on to improve the training in life cycle management, ADP contracting, and management. In the area of ADP improvements, the Naval Data Automation Command has in its long-range plan to streamline the review, approval, and acquisition process; to improve training and career management of ADP people; the integrated ADP planning is planned Navy-wide; and to develop standards and procedures for ADP functions and to reduce the overlap and duplication in hardware and software. The Defense Logistic Audit Service is studying the Air Force Shelf Life program and doing a cost benefit analysis of that particular program for applicability within the Navy.

In the area of personnel issues, just to name a few, the Department of the Navy is looking at the Position Management Program and looking toward developing normative data and grade conversion guidelines, and developing a system to identify controls and eliminate ineffective position management practices. The Navy is also conducting a study of the staffing process and they have issued instructions for two activities to identify staffing actions and to set up tracking systems. There are also studies about to be conducted in what would happen in the Personnel Staffing area if you eliminated or modified some of the processes within that total process and to look at the impact of that and whether or not it would speed up the process and still result in getting quality people. One accomplishment that has already occurred is that the National Agency Check and Inquiry people have speeded up their particular investigations significantly.

The Navy has issued an instruction reducing the levels of review required to approve Incentive Awards. That came out roughly a month ago and in addition to that, the instruction also said that committee review of Incentive Awards would no longer be. The Navy is also developing a Crediting Plan Bank to reduce that duplication of effort between supervisory and Personnel Department people.

These are just a sample of actions being taken to remove or reduce the impact of some impediments. To paraphrase Professor Russell Akoff's remarks at a NAVMAT lecture given recently, he said, "Even after you have removed the problems or impediments, you may still not have the organization you want, but it may allow you to see the organization in a maximally productive state." Therefore, while removing impediments can be beneficial, it may even be better if they could be prevented from occurring in the first place. And here are some of the steps that might be taken.

Two of the big issues that were identified and recommended by the Navy Personnel R&D Center were the areas of control and communication. Hughes Aircraft, in their report on R&D productivity, stated, "Don't permit too many or overly tight controls that restrict creativity, innovation, and intelligent risk taking."

Delegation of authority - let the managers manage. Keep the authority commensurate with the responsibility. Set goals. Check the progress against these goals. And hold people accountable. Autonomy, if it can be achieved, encourages initiative and enhances motivation and productivity. Keep controls simple to administer. Reduce the paperwork, the administrative burden on management. Reduce, or at least coordinate, requirements - requirements that are coming in from external to the organization and also within the organization. Develop effective communication. This particular area really cuts across most of the other areas - it's rather pervasive. In the area of downward communication, again, setting clear goals and objectives, communicating those goals downward, concentrating on outputs versus activities, and ensuring consistency at the lower levels. Everyone marching to the same drummer. Upward communication - tap that expertise that is down at that lower level, communicate those suggestions, those ideas upward. There is also a great need for lateral communication, coordination between units at the same level within the organization. It might be coordination between the Planning Department, Production Department, Personnel Department.

Developing effective managerial skills - there is a need for training in labor management relations, how to motivate employees, how to handle interpersonal relations, that is, how to deal effectively with subordinates in a supportive, constructive manner.

Rewarding effective performance - and this includes or addresses more than just withholding sanctions or negative rewards, such as blocking advancement because a manager has increased his productivity, but actually going out and offering incentives, positive

incentives, for taking initiative. These incentives could include such things as recognition, monetary rewards, increasing budgets for the productive units, advancement, more responsibility, personal development opportunities.

Balancing long- and short-range planning efforts, particularly regarding investments - long-term modernization plans are in effect now, but they do address long-range goals. They should be balanced against short-range programs such as the Navy's Productivity Enhancing Capital Investment Program and the Cost of Ownership Deduction Investment Program. These will address the short-range issues while the modernization plans will address the long-term issues, and include all organizational levels in that planning, if at all possible.

That concludes my presentation on Barriers to Productivity. Once again, I'd like to go back to looking at the positive aspects of this, rather than the negative. It's something that any organization can do, that is, to do an organizational diagnosis, find out where some of the problems are, what those problems are, address those problems. They will or can result in some direct improvement in productivity, but they can also create the proper climate that is needed to enable productivity initiative to flourish. Thank you.

Dr. Shipper

Thank you very much. Do we have any questions that Mr. Sniffen could answer?

Q: Why isn't there representation on the task group at the field level?

Mr. Sniffen

The issues that were addressable at the field level were reported back to the field activities after the study was conducted. They took those issues and have independently taken some actions to address those. Most of the issues that the task group was addressing really are at either the Systems Command or at the NAVMAT Headquarters level.

(The remaining questions and answers were not recorded.

Mr. Warren E. Matthews

(Introduction and the beginning of the presentation were not recorded.)

detail level as a part of the design and manufacturing process. Finally, the ability to incorporate changes. In the military material acquisition business, there is a lot of change traffic. In the past, a fair amount of that has been because of inadequacies in design that had to get cleaned up once somebody started trying to build it. But a very large amount of that change traffic comes from actual changes in the perceived need, changes in the details of the requirement from the customer's point of view, not only from the producer's point of view. The existence of this integrated computerated world with internally self-consistent data bases where you can make a change in one small aspect of it and that gets propagated accurately throughout the entire data base is of tremendous assistance in being able to put changes in without lousing up the whole thing. It has been true in the past that you put in what ought to be a small change and you shut down the production line because you forgot about some interaction somewhere. The computer doesn't forget about those things.

These are examples in which the availability of technology specifically in the form of large integrated computer systems is providing tremendous aids to management. I'm talking here really about computerated management and the impact upon productivity of the entire system of providing these technological aids to the management element of the system. But there is one other thing I need to address. And that's the fact that the most important productivity improvements come about not when you simply make it possible to do more efficiently what you've already been doing, but when you actually change the nature of the process itself. The sort of thing that has happened by the coming along of transistors replacing vacuum tubes. The first change was you got less power drain, smaller, more efficient devices to do the same job we did before. But then we were able to move to integrated circuits and now have a whole new world that could never have possibly been done with vacuum tubes. The same thing is happening in management. Let me show you a few of the things that are happening that are changing in a fundamental way the process of management.

Number one - the assured dissemination, completely and accurately, of requirements. Any of you out there who have management or command responsibility and have coped with how to make sure that the system really does what you want will have some feeling for this. You work through a hierarchy of people, you work through a hierarchy of regulations, you work through the hierarchy that Bob was just talking about and maybe it comes out the other end and maybe it doesn't. Maybe it comes out distorted. But with the computer system, you can get throughout the entire operation, instantly, a precise, untranslated statement of what the requirements are and to the extent that those requirements impact other elements of the system, either of the management side or the product itself, the computer can automatically provide that kind of internally self-consistent transmission of both the requirements and of their impact. There is a pervasiveness of communications that the computer systems offer us that is a real quantum

difference from our prior ways of doing business. Incidentally, it has provided some heartburn for middle managers. If you read the literature on motivation, read the literature on surveys that are taken of employee groups as to do they feel they understand what top management wants, do they understand what's going on, do they have the tools to do their business, all the attitude surveys, increasingly it is the middle management that is exhibiting anxiety because there is a closer tie between top management and getting the work done, and middle management is wondering more and more, do they have a real job. Not everything is plus - there are some minuses.

Another major qualitative change in the process of management I refer to as communication via programming. In a computer integrated management and communication system, there are two primary means of communication. One is by way of the data stream itself; electronic mail is a perfectly good example. You type in a message and anybody to whom it is addressed gets it, accurately, quickly. The data stream is one way to communicate. But there is a far, farmmore powerful way to communicate and that's what I call communication via programming. Let me give you an example. The manufacturing people have been trying for decades to get engineering to understand how to design things so that they will be producible. We have generated producibility handbooks; we have had training courses to bring the engineers into the factory; we sit them down for a week; we show them how the factory works; show them the automated machines; we show them how they are programmed; we point out that if they'll just do things on tenth-inch centers it will be easier to make; etc. etc. etc. But it has been fundamentally a matter of talking to them, hoping they listen, hoping they remember, put reference data in their hands, hope they read it, an ongoing struggle. Now, there's a whole new way to communicate producibility to the engineers, not only more effectively but totally unavoidably. That is by having your producibility people in manufacturing participate in the design of the computer-aided design program, so that when the engineer goes to design something, the producibility factors, the producibility criteria, the producibility ground rules are an inherent part of the mechanism that is helping him do his design. You have to be careful - you can't carry this so far as to build a computer-aided design program that won't, that can't design something wrong. If the computer-aided design program is such that the engineer goes in and says, I want to do thus and so, and he taps, taps, taps on the keyboard and plays around with his light pen and he does all the things you're supposed to do with a CAD terminal, and the CAD terminal says, You can't do that, dummy, that won't work - try again. Or even worse, it says, Now what you really wanted was this, and the computer shows him what he should have done. You know what's going to happen about the second time that occurs - he's going to kick in the face of the tube and he won't put up with it.

But you only have to be a little more subtle, as we have been in some of our programs at Hughes. You make the computer a responsive tool to the engineer. It will design anything he wants it to. If he wants to design an underground, finless, supersonic rocket, he can do it. And it will help him. But - in the upper right hand corner of the screen, when it shows him what he wanted, it also says, Now, Friend, your current design contravenes these seven producibility criteria - wouldn't it be fun if you tried to minimize that list? And then the engineer thinks, If I did this little corner over here and that little corner over there, I could take care of that one. Our experience - and we're talking human motivation and the way real people work - our experience in our sheet metal designs operation at Fullerton is that between 95 and 96 percent of the equivalent drawings in the computer data base - of course, they're not existing as drawings, but the data packages that would be drawings if you had to put them on paper - between 95 and 96 percent wind up having absolutely no nonstandard elements whatsoever. If you make producibility - or anything else that has to do with productivity - appear to the designer as a constraint on his function, he's going to rebel against it, but if you make it appear to him as simply a part of the puzzle he's trying to solve, he gets as much kick out of solving that puzzle as any other - and it works.

So, by having the things that you most importantly want to do - producibility in design, or things that would have to do with cost effectiveness or whatever - build them into the programs that are doing the aiding and you've got a quantum level higher communication than merely transmitting through the computer words to the man who's using it.

Finally, decision-making via simulation. I've already talked about our ability to do fly-before-build, try-before-breadboard, etc., and so that's one piece of this. But there's another piece of critical importance to management. Suppose you have a CAD-CAM program that has enough of the right kind of information or the sub-programs within it to do a design-to-cost job. You've got enough of a simulation of the manufacturing process in the computer that the designer can play a potential design against it and find out what it will cost. And he can play a design modification and find out what that will cost, and thereby decide which is the better design from a cost point of view. Most of us have by now, to some greater or lesser extent, that kind of capability in our CAD-CAM programs. But notice, if that degree of simulation of the manufacturing facility exists in the program, then the manager of the manufacturing facility can use that simulation to decide whether to put a new kind of machine tool in in place of something he already has. Or whether automating some process will be better or worse. He can simulate the functioning of his operation, even though it was put there originally to simulate something for the use of the designer. And that is going to be a broader and broader, more pervasive thing we're going to find - manufacturing management, engineering management, program management, general management will be able to use the integrated set of computer

GATEWAYS
TO
PRODUCTIVITY

HUGHES

CONTRIBUTORS TO PRODUCTIVITY

HUGHES

MANAGEMENT
- BRING INTO BEING
- ORGANIZE

TECHNOLOGY
- OF PRODUCTS
- OF MANUFACTURING

INVESTMENT

WORKFORCE
- EFFECTIVE APPLICATION
- MOTIVATION

DEMANDS OF ADVANCING TECHNOLOGY ON MANAGEMENT

HUGHES

MANUFACTURING PROCESSES INCREASINGLY TECHNICAL

- TREND FROM FAB/ASSY TO PROCESSING
- INCREASING DEPENDENCE ON SOFTWARE
- TROUBLESHOOTING INCREASINGLY COMPLEX

SHIFTS IN NATURAL RESPONSIBILITY BOUNDARIES

INCREASING NEED FOR CLOSE INTEGRATION OF ENGINEERING AND MANUFACTURING

THE COMPUTER-AIDED WORLD

HUGHES

WIDE-SPREAD COMPUTERS AND TERMINALS

INTERCONNECTED NETWORKS

COMMON DATA BASES

PRODUCTIVITY CONTRIBUTIONS OF COMPUTER-AIDED MANAGEMENT

HUGHES

EVERYBODY WORKING ON SAME PROBLEM

RELIABLE COMMUNICATIONS

VERIFICATION OF DESIGN PRODUCIBILITY

ACCURATE COMMUNICATION OF DESIGN

"FLY BEFORE BUILD"

ACCURATE INCORPORATION OF CHANGES

QUANTUM ADVANCES IN MANAGEMENT CAPABILITY

HUGHES

ASSURED DISSEMINATION OF REQUIREMENTS

COMMUNICATION VIA PROGRAMMING

DECISION-MAKING VIA SIMULATION

programs to make much more intelligent decisions. We've been doing that for years, of course, relative to military command. Now we're talking about doing it relative to command within industry, within an art, whatever.

So I submit to you, gentlemen, that among the factors that contribute to productivity - that you'll hear more about tomorrow - one of the principal of those is technology. We have tended in the past to think of that contribution primarily in its direct impact on the production process. I submit that technology is having some pervasive impacts on the management process that are going to, over extended time, have a yet more pervasive impact on the productivity of our entire enterprise.

Thank you.

Dr. Shipper

Do we have any questions for Dr. Matthews?

Q: I have a couple of questions. One, you talked a lot about using the computer to help and in the design. How about in the area of maintainability of the equipment?

Dr. Matthews

The computer is absolutely critical there. One of the major problems we have had relative to field maintenance has been diagnostic skill levels, the ability to take some of this sophisticated equipment and find out what the problem is. One of the major uses that is being made of computers in that area, a typical example, is the so-called guided probe technique, where you have built into the computer - and you can get it out of the design data base as a matter of fact, you don't have to recreate it sitting on the outside - you have enough knowledge of the system and how it functions and how it might malfunction if something were wrong, that the maintenance man can feed in symptoms and the computer will come up in priority order with probable difficulties. You see that in a modern xerox machine with its failure codes - "See Card A-13" - in a much more sophisticated way, we can do that. The process of faults in the process of manufacturing is in many ways very similar to your maintenance processes out in the field, and being able to tap that data base in terms of experience - what's been the experience on the failure rate of various components or various subsystems - can be a very valuable tool in prioritizing efficient maintenance. Am I addressing your subject, sir?

Q: Well, to a point. The concern I have is that as we continue to mechanize the test equipment, one of our largest costs has been the design of test program sets. If in the original design of the equipment we could build in a more maintainable piece that required fewer and fewer test programs, then we could certainly reduce the maintainability costs.

Dr. Matthews

The question is, is there some way to design the primary gear itself to take the load off. The answer is absolutely yes. Self-test is a thing that has been coming along more and more, and it seems to me that as we move to a broader and broader use in electronics, for example, of large-scale integrated circuits, the right level at which to do built-in tests is at the individual circuit level, the individual slice. We're getting to the place now where you have to have so many active elements on a small chip of silicone that we're really not real estate limited anymore, as far as that part of the real estate is concerned. If it was an inherent part of the design process, that you design the circuits such and partition the circuits in designing them such, that there is access and then you build in the utilization of that access right into that same chip of the primary self-test capability, so that the self-test at the subsystem or system level is much more global, and whatever you have to pull up in the way of yellow gear is yet more global, that's the way to go. As a matter of fact, I think you can go one step further. It won't happen tomorrow, but I think it's bound to happen. You know that one of the most effective ways to get reliability is through redundancy. And if we have all this additional real estate on the silicone, the thing you really ought to do with each slice, with each chip, is not merely to put in the self-test, but put enough spare elements to be able to do self-repairs. So the real answer to the maintainability problem is to make gears that never fail. And I think, with large-scale integrated circuits, we're going to wind up there.

Q: Can we stand all this data availability and the ability to do something about it at the top levels?

Dr. Matthews

That's a very real problem. I don't have a clean answer to it. It is certainly true that the large-scale integrated computer systems data bases, sometimes referred to only partly jokingly as "Big Brother", can put a tremendous amount of power at the top, or at various other places in the system. I won't try to answer your question because I don't have an answer. I think the thing we need to do, just as we need to think very carefully about computer security as we go to a paperless financial community, we need to think about computer security as we go to the design of classified equipment on computers, I think we need to think about that, also. I'm not quite sure how you build a system that is adequately management-proof. In the past, we have been trying to make management more effective. Maybe we've crossed some thresholds.

Q: One of the real problems that we have, I think, is accuracy of the data base. Unless that data base is accurate, unless you have a method of cleansing the data base, you're going to have terrible problems.

Dr. Matthews

The point has been made that to an increasing extent, as your computer systems and your data bases become more global, a key problem is the accuracy of the data base. And, of course, the question of the danger of the top executive having access to the machine is that he may take action based on inaccurate data, not knowing that it is inaccurate data. One of the advantages of middle management is that it is close enough to the action that it can assess the accuracy or the lack of accuracy of what passes for the data that it and its own bosses are using. We have some important new broad sociological problems to face, gentlemen.

Q: There is a great tendency to claim that technology will solve all the problems. But what the computer can do for you is dependent entirely on the people that programmed it, and without competence in that programming, the computer is just a big, dumb machine.

Dr. Matthews

That is absolutely correct. The other side of the issue, which some of these other questions have addressed, is that unfortunately that computer, in addition to being a big, dumb machine, is a big, rather powerful machine. So it is certainly true that the competence, the utility of the computer in effecting productivity depends ultimately on people, not on itself. It does enhance, it does extend the effectiveness of those people through the adequacy of communication and the assurance of accuracy, and through a precise job of clerical transmission, but I agree with you. At the same time, we have to recognize that the computer, particularly in the form of large integrated systems, has a lot of power and you can't always stop that power by the admonition you have properly laid on it. We tend to put more credence on what comes on the television tube than what somebody tells us, and yet, the only thing that comes out of the television tube is what somebody said at the other end. But somehow the fact that it came through a machine makes it affect us more. I think there are a number of problems like that that we need to seriously look at and research and think about.

Dr. Shipper

Our next speaker is going to be Dave Francis. Dave is going to be addressing us on a topic that I have received a great deal of questions about. The topic he is going to address is called Quality Circles. It's easy to talk about somebody and tell you that he has a graduate degree from VPI, he's been a Director of Continuing Education at Virginia's second largest community college. But more important about Dave Francis is what I call organizational credibility. Dave Francis was the individual, the single individual who took it upon himself to initiate an action called Quality Circles in the Federal Government. Not just in the Navy, but he was the first one to initiate and implement

an activity called Quality Circles in the Federal Government. He has gained credibility in the Federal Government by initiating an action that has a five-to-one payback ratio. The investment was $300,000 in Norfolk; the return on that was $1,500,000. Dave Francis is living proof that one individual can make a difference. He is also living proof that one individual in the Federal Government can make a difference. He is also living proof that you don't have to be a Flag level officer or an SES to make a difference. At the time he initiated the Quality Circles, I believe he was a GS-11, and we know where that sits on the totem pole. He is also living proof that you don't have to do it from the headquarters. He is also living proof that you can institute a quality of work program, a productivity enhancing program in a unionized work force. He has that credibility that everybody would like to have - organizational credibility. The ability to get desired results. Dave Francis.

Mr. Francis

I was asked for a biographical sketch and I don't recognize that as the biographical sketch which I gave out. There's something that I need to make perfectly clear right from the front of this presentation. There are a lot of people at Norfolk Naval Shipyard, where we started Quality Circles, and in the Federal Government that had an awful lot to do with starting the process. One thing we don't want to do is to think that we are indispensable to a situation. That's not the case. A lot of people have credit and a lot of people are responsible. I want to make that perfectly clear.

Most of us in the room today have heard of Quality Circles. It has been mentioned several times. But I think that probably few of you are really aware of what we're talking about. The basic view I often find when I speak to a group like this is that Quality Circles is another program, a zero defects situation, but what we're seeing in Quality Circles is much more pervasive a situation in the work force. A real change is taking place and I think you've seen some of that today. There has been a great deal of emphasis put on technological change and technological improvement and that certainly is very important and one of our very strong points in this country. But we have a complex integrated work force and I was interested to see that that complex integrated work force is now being computerized. But it seems to me that we have two choices. We can design people out of the system so we do not have to contend with complexities, or we can design systems within which people can work in a complex manner. I think that basically is what we were trying to do with Quality Circles.

A new theory is developing and I'm sure some of you have heard of this theory. William Ochee of UCLA has just put out a book on it and it is a sort of extrapolation or take-off on the X and Y theory, and this is something we're trying to accomplish with Quality Circles.

The first Quality Circle was registered with the Japanese Union of Scientists and Engineers (JUSE) in 1962. The concept was conceived by Dr. Kaoru Ishikawa, a professor of engineering at Tokyo University, and developed under the sponsorship of JUSE. Quality Circles fuse the quality sciences introduced to Japan by Dr. Joseph Juran and Dr. W. Edward Demming with the theories of Douglas McGregor, Abraham Maslow, Frederick Herzburg, and other humanistic behaviorists. The concept recognizes that the people doing the work have the ability to answer many of the quality and productivity problems facing us today. This approach taps the creative intelligence of the employee and provides him the means to use his mind, not just his hands.

Quality Circles are small groups of volunteers who meet on a regular basis to identify, analyze, and solve problems they encounter in their work environment. Members of a Circle are all from the same work area so that the problems they select to work on are familiar to all of them. The membership is strictly voluntary. No one is forced to participate, and no one is kept out. The ideal size is six to eight people, but can vary from three to fifteen. The Circle should never be so large that each member cannot have sufficient time to participate and make a contribution in each and every meeting.

The objectives of the Circle are to reduce errors and enhance the quality of the goods and services provided by the members of the Circle. The Quality Circle concept inspires more efficient teamwork, promotes job involvement, and increases employee motivation. The concept builds an attitude of problem prevention and creates problem solving capabilities in its members. Quality Circles develop harmonious manager-employee relationships, and help improve communication within the organization and with the support organizations.

Through solving quality-related problems, the members of a Circle eliminate many of the factors that contribute to the dissatisfaction they have with their jobs. A higher level of quality from each organization and each individual within that organization is directly translatable into the effectiveness of the United States' most important defense systems. Further, reduced defect levels and higher productivity and lower costs, improve customer satisfaction and cortribute to job stability.

Many activities may occur during a meeting -- identification of a theme or problem to work on, analysis of a problem, or the preparation of recommendations for the solution of a problem. All the activities of a Circle are directly job related. Circles are encouraged to establish an objective and develop a plan to achieve it. The plan is broken down into objectives so that progress can constantly be monitored by the Circle.

Meetings are held once a week for one hour. Ample time should be allowed for the Circle to adequately conduct their meeting. Problem identification can come from Circle members, staff, technical experts, management, etc. Problem selection, however, is strictly up to the members of the circle.

Occasionally, a Circle project overlaps into another organization, but this should be avoided when possible. Circles generally have enough problems to work on in their own areas; however, if it does happen, the Circle coordinates their efforts through the Facilitator. Management of all affected organizations is kept advised of Circle activities at all times.

Experience has shown that most Circle recommendations pertain to the work being done by the members, not the overall mission. Very few of the recommendations made are of a big budget nature and in most companies, over 85 percent of the suggested solutions are implemented. When management does say no to a recommended solution, they provide the Circle with the reasons the solution wasn't implemented. The Circle can then evaluate its solution and follow through accordingly.

When a Circle needs the help of a specialist, the support organization is requested to assist in solving the problem. Care must be taken to ensure that the specialist does not solve the problem identified by the Circle on his own. If this is allowed to happen, the Circle will never learn to solve their own problems. The specialist is asked to assist the members in solving the problems they have identified, to work with them, not to solve the problem on his own.

The Facilitator is the individual responsible for coordinating and guiding the Quality Circle program within a given organization. He is responsible for training the Circle Leaders and Members, and forms the link between the Circles and the rest of the organization. The Facilitator is on staff and should report directly to the top management official in the organization for which he is a Facilitator. The Facilitator trains the Circle Leaders in group dynamics, group problem solving techniques, and group leadership. The Leader then assists in training the Members in Quality Circles techniques.

Quality Circles employ a structured group problem solving pattern utilizing the following techniques: brainstorming; data gathering; check sheets; pareto analysis; cause and effect problem; and histograms. The primary function of a Circle is to analyze and solve problems. To solve a problem, all pertinent data must be available. Training in data gathering and other techniques is necessary to assure accuracy. The Circle Members receive their training during their weekly meeting after the concept has been presented to them and volunteers have formed a new Circle.

Every organization could benefit from Quality Circles. Each organization, regardless of the work performed, can benefit greatly from allowing the people the opportunity to become involved in doing their work in a quality-conscious manner.

If an area has 50 employees, and all of them wish to become Circle Members, six Circles are recommended. The Circle represents an investment in people and in the organization. Experience has shown that the six Circles would not duplicate activities. Each will contribute in its own way, complementing the efforts of the others.

Quality Circles has failed in some companies. Research into the causes shows that there were violations of the essentials of a successful program. The interest and continual support of management is essential to the survival of any Quality Circle program. Management must believe that an investment in people building is worthwhile. The entire Quality Circle concept is based on trust, respect, and caring. People building is helping people become better than they already are. Management must believe that the people have the ability to develop and grow. Training must be provided and management must have the patience to allow all this to happen. Most working people have never in their lives been asked to truly participate in the "system" and must be granted time to learn to cope with this responsibility. There is no short cut to success. Management must have confidence, trust, and patience. When fully implemented, Quality Circles create in the individual a sense of participation and contribution. This technique recognizes the individual worker as a human being with the ability and desire to participate in solving quality problems. Quality Circles work anywhere people work.

Quality Circles provide a unique opportunity for U. S. industry to tap the intelligence and creative capacity of millions of people, in order to stem complacency towards poor quality and its inherent high cost. The use of Quality Circles, to truly involve production employees and others, is a dramatic form of job enrichment. It affirms that management believes the individual doing a job knows more about it than anyone else, and can suggest the changes necessary for improving it.

Quality Circles is a process which involves everyone in the organization in solving quality problems. As every job requires measurable work, the people doing those jobs affect product quality in some way. It has been clearly demonstrated that well-informed and properly-trained people can best solve the problems involving their own work.

Quality Circles are based on a very simple concept. Nearly all people will take more interest and pride in their work if they are allowed to influence decisions made about their work. Quality Circles is a technique which restores to the industrial scene an attitude many think has long been lost. This technique

recognizes the individual worker as a human being with the ability and desire to participate in solving product quality problems. It demonstrates the basic tenets of McGregor's "Theory Y" in a practical manner.

McGregor attaches the "Y" label to that managerial behavior which recognizes the intellectual potential of the average human being. Quality Circles taps this potential by involving people in quality consciousness. It is much more than a sloganeering campaign directed at the employee. Instead, the employee is a voluntary, integral part of Quality Circles.

Frederick Herzberg, in his championing of job enrichment, stipulates several essential ingredients of a good job: (1) opportunity for new learning; (2) direct communications authority; (3) direct feedback; and (4) personal accountability. It is his firm conviction that true motivation is derived from the contents of the job itself. Quality Circles responds to Herzberg's admonition and concentrates on these four precepts.

The Quality Circles Program operates in the following manner. Supervisors and Managers are introduced to the Circles concept. Interested Supervisors are then trained in the techniques of organizing, training, and maintaining the Circles. The Supervisors, as Circle Leaders, then present the program to their people. The potential Circle members are then asked to volunteer for membership.

Each Circle is formed of three to fifteen people who do similar work. The Circle members meet weekly with their Leader. The first few meetings of a Circle are spent familiarizing the members with the basic Circle techniques in which the Leader has been trained. Using their new skills, the Circle members then identify problems in their work areas which they wish to solve. They conduct research, investigate within their scope, and request assistance from other organizations for those areas beyond their scope. Once they arrive at a viable solution to the problem, the Circle presents their findings and recommendations to Management.

Quality Circles were implemented at Norfolk Naval Shipyard in June of 1979 based upon the philosophy that all people deserve an opportunity to work -- in a stimulating environment -- one in which they are recognized as capable, contributing members of the organization.

Quality Circles are a uniquely-designed concept with proven ability to harness the creative talents of employees at all levels. Because the quality and productivity of a person's work is much affected by attitude, Quality Circles is aimed towards changing attitudes about work. Quality Circles is much more than a system or program imposed upon an organization -- it is a way of thinking.

The first step in the implementation at NNSY was to conduct a management review of the concept. A team composed of shipyard employees was established to review literature, determine if the QC concept was applicable to the Shipyard, and to develop a recommendation.

The team reviewed current literature, interviewed key management personnel, and visited a private company currently working with Quality Circles. Shipyard union representatives were briefed. Positive responses were received from the union.

The committee made the following recommendations:

a. A pilot Quality Circle project be established at the Norfolk Naval Shipyard.

b. The pilot project be conducted over a one-year evaluation period to determine if the concept is, as expected, useful and applicable to the Shipyard.

c. The project be established on a voluntary basis in a production shop and a support code, such as personnel or supply, to allow comparisons of the concept between differing types of organizations within the Shipyard.

d. A Steering Committee with representatives from involved shops and codes be established to guide the operation of the pilot project and to ensure full support from management. The appropriate union official should be included on the Steering Committee.

e. A position be established on a one-year temporary basis to provide a Facilitator for the pilot project. The Facilitator should be located in a neutral position with the ability to work with all Circles.

f. A QC consultant be hired to assist in the implementation of the project. The consultant would provide training for the Facilitator, management personnel, supervisors, and Steering Committee. He would furnish complete training and operating materials for the Facilitator, the Circle Leaders, and the Circle Members.

g. An appropriate code be assigned the responsibility for the implementation and operation of the pilot project to ensure that the program is conducted in a uniform manner and that the necessary support is provided. The responsible code would also provide clerical support and assistance.

The Shipyard Commander directed that the pilot project be established with Code 180 (Employee Development Division) having program responsibility.

The first step in the implementation process was to establish a Steering Committee. The Steering Committee was composed of key management personnel and union representatives. The first action of the Steering Committee was to establish a central goal and to select a Facilitator. The central enunciated goal was to improve quality at NNSY. The realization of this goal has brought about improvement in the following areas: productivity enhancement; safety; communication; employee grievances; job satisfaction; cost reduction.

In selection of the Facilitator, it was necessary to have a person who was truly committed to the concept and had enough authority to work with top management, as well as first line supervisors and their employees.

The Committee decided to use a General Foreman WS-13 as Facilitator and a qualified volunteer was selected. Top and middle management support was found to be absolutely critical to the success of the program. Therefore, the Facilitator began by briefing Superintendents as the first step in the actual implementation process. Where support and interest were found, the next level of management was briefed and so on down the line to the work level.

Six Circles were formed initially. Two were lost due to weak leadership or disinterest on the part of the first line supervisor. Later, five additional Circles were formed to bring the total for the pilot project to nine. To provide a comprehensive evaluation of the pilot program, Circles were formed in various areas in the Shipyard, such as supply, maintenance, and production shops.

The first step in the operation of the actual circle process was the training of the Facilitator and Circle Leaders. This was accomplished with the assistance of a civilian Quality Circle consulting firm. Three days of training were provided to the Circle Leaders and the Facilitator.

Step two was to begin training of Circle members. Since Circles meet on a regularly scheduled basis, one hour per week, it was decided to conduct the training during the first eight meetings. We obtained from the consultant, packaged training materials which greatly facilitated the training process. Training is a joint responsibility of the Circle Leader and Facilitator. Where weak leadership was in evidence, the Facilitator took the lead. However, where the normal Circle Leader was willing and able to conduct training, the Facilitator assumed an assist role.

A well organized Steering Committee is a must. Selection of the Facilitator is the most important decision that will be made in establishment of a Quality Circle program. The person must be able to work at all levels, must be creative, and above all, must be able to work well with people and be aware of the political atmosphere within which he is operating.

Management support is required. Union support is desirable and should be solicited. The program must be voluntary, but management should provide encouragement in establishing Circles in areas of greatest need. Circles members must feel free to work on problems they choose to work on (within established limits). The Facilitators must keep management informed of problems Circles have selected to solve, and on the progress Circles are making.

Quality, not quantity, should be of first consideration. Expansion will come of its own accord as word-of-mouth spreads success stories.

Adherence to the Quality Circle concept and procedures is mandatory for a successful program. A major function of the Facilitator is to assure that procedures are followed. Relaxation of procedures will cause Circles to be non-productive and eventually to disband.

The Quality Circle concept has high potential for improving quality and productivity. However, if not managed carefully, the concept could be harmful to an organization. Once a solution to a problem has been approved by management, the Facilitator must follow up on implementation to ensure that the solution is carried out. Solutions which have been approved and are not implemented or are not implemented as proposed will destroy all positive gains made from the program.

I'll be glad to answer any questions you might have.

Question: Who are the facilitators?

Mr. Francis

The first facilitators we thought would be most effective were the middle managers. We picked general foremen initially. We felt they could work on both sides pretty well - they didn't feel uncomfortable with top management and they had been through the ranks and could work pretty well with labor. But we found that it wasn't any specific level of person who was effective. It was a type of person who could understand people, understand what was happening in the workplace, and felt they could make a change. That was very important. People who felt positive about what was happening and felt they could have an impact. That's who we started selecting and it varied. It went from general foreman level - in fact, we had a planner and I believe now we have a mechanic who is actually serving as a facilitator.

(Question is unintelligible)

Mr. Francis

We brought in a consultant initially. When we started in 1978, there was very little information available. I know of people who started on their own, just got the material and did it, but I would recommend some outside help because there are a lot of intricacies that you may not be aware of. Let's face it -

you're opening up people and it's very complex. If you don't make a commitment to it, plan it well, know what you're getting into, you shouldn't be involved in it.

Q: Can you suggest some consultants?

Mr. Francis

We used J. F. Beardsley, but there are several good ones in the field now.

Q: Are you concerned that Quality Circles will generate so many solutions that managers can't implement them?

Mr. Francis

First, we integrate the implementation responsibility into the system, so that no only the managers are responsible, but so are the workers. There is a great deal of ownership. While Circles solves a problem, it may not be the school book of best solution to the problem, but there is a tremendous amount of ownership involved, and they will tend to make it work and tend to want to get it implemented. We haven't had that problem. It's a slow process. We do not put time limits on it, and a Circle will take anywhere from three months to six months to come up with it. We have run into a situation, in fact, where a Circle came up with a solution, they planned it, identified the resources, designed the materials, and it was turned over to Planning, and a Planner looked in a catalog and ordered similar materials that didn't meet the specifications. That had a negative impact. We had to go back and correct that because when they got what they had designed, it wasn't what they had designed and it caused a problem.

Someone mentioned before about a computer that they had designed that an engineer could work with and it didn't come back with responses that would cause him to kick in the face of the computer. That's kind of what we're getting into there. We can do it with computers, but how are we going to do it with management? So in terms of implementation, it's a very careful process and we have to work with it very carefully.

Q: You said the suggestion system wasn't working. Are you still running it parallel with the suggestion system?

Mr. Francis

I hope I didn't say that. The suggestion system is very productive and in fact, the Quality Circle effort is small compared to the savings we get out of beneficial suggestion programs. We do not in any way want to hinder or impede

individual creativity in the work force. So what we did was say to Circles, if you have a project and it is implemented, you can put in for a beneficial suggestion under our existing suggestion program. To this date, none have, although we have had some very substantial savings, which indicates to me that money isn't the motive. They just don't do it. And all they would have to do is write it up, because it's already been implemented. That's important. We do not want to try to integrate them. Some companies have done that, some have done away with the beneficial suggestion program and gone to this, but I don't see that yet. We're running parallel. We don't know what the impact would be, and until we do, we're not going to make any suggestions along that line.

Thank you.

Dr. Shipper

I know there are probably more questions. Dave will be more than happy to answer them: just buy him a drink.

Our next speaker is going to be Herb Held. He's going to speak on Labor Management Relations. Herb Held has been a productivity consultant in the Washington, D.C. area for 15 years on labor relations - productivity consultant both to private and public sectors. He has been a consultant to the DOD, the Army, the Air Force, and I guess to the Navy, though he left that off on his Vitae - also to the DLA. He has also spent 17 years with General Electric in Personnel and Labor Relations. His education and background have to do with labor relations, industrial engineering, and also law. He has a degree from Cornell University and the University of Virginia. Herb Held.

Mr. Herbert C. Held

Good afternoon. I feel like the proverbial thorn between two roses, following the superlative Dave Francis and preceding the cocktail hour.

Asking me to speak about the labor relations implications on productivity initiatives in a few minutes is difficult. I'm sure I can't do that. I'll try tc confine myself to the labor relations side of employee involvement.

Employee involvement is a term that some of us use to cover all facets of integration between management and labor, management and union, management and employees, where they dedicate themselves ostensively to the improvement of work effectiveness and to productivity....whatever that may mean. Productivity means 100 things to 100 people, or a thousand to a thousand.

Let's look at the Japanese for a moment. They historically and currently have maintained a very comfortable relationship between management and the union. It is non-adversarial and it has worked very well to their benefit, obviously. Here in this country, unfortunately, our labor management relationship is anything but that comfortable. It is adversarial. It is structured on an adversarial basis and whether you like it or not, that's the way it is. I refer you no further than the current negotiations between the baseball owners and the major league players' association, which may well erupt in a strike next week.

When you talk about productivity initiatives involving employees, and I feel very strongly about the value of those, because I personally feel that nobody knows a job better than the employee - I don't care about engineers, I don't care about MBAs from Harvard, I don't care about sophisticated computer programmers - I contend that the employee knows his or her job better than anybody else. It's management's responsibility to make it convenient and comfortable for an employee to share with his management what he knows in order to improve the overall system. But where you have a union involved - and I would like to point out that as far as my remarks today are concerned, they apply equally to private and public sector labor union and management relationships, unless I otherwise note - where you have a union involved, they, by law, are a key principal and this is where I see some problems today with some of the employee involvement programs that are being adapted in this country in both sectors.

First of all, if I may comment on the Quality Circles, as Dave pointed out, this is an innovation that has come from Japan predicated upon the ideas of Drs. Juran and Demming some 30 years ago. Japan has done very well with Quality Circles. Some 10 million workers in manufacturing and service industries are covered by Quality Circles. And it has become a fad here and I'm very alarmed about that, very frankly. I'm alarmed because there are two factors that I feel absolutely must prevail, and without which there can be no success. One of the factors is management commitment. Management commitment does not mean the CEO signing a piece of paper which says, "I'm committed." That's not management commitment. Management commitment is when the boss does not give hell to the production manager because they failed to meet their shipping schedule that particular month, and point out to the production manager, "That's because you had your employees tied up in those meetings last week - those Quality Circle meetings." That's part of management commitment.

As I look around the country, both in the private and in the public sectors, I do not see the type of management commitment

that convinces me that Quality Circles are not going to go the way of zero defects, and operations breakthrough, and zero-based budgeting and a whole host of other programs that you and I have long since forgotten. Conceptually, I think Quality Circles are tremendous, but they've got to have the management commitment.

Secondly, where unions are involved, the unions must be involved. I speak as one who has never earned a nickel from a labor union. I've worked for management all my life. But I am a realist and I do submit that if you do not involve the unions early on, sooner or later they are going to pull the rug out from under you - I'm speaking to you now as a manager - and you're going to be left there with egg on your face.

As far as involving the unions is concerned, it does not mean to sit down and negotiate with them on Quality Circles or labor management productivity programs, or any of a host of other joint programs that are available to you....and again, to you both in the private and public sectors. I shudder when I hear the term, "productivity bargaining." Why should management sit down and negotiate with anybody - a labor union or anybody else - about something as critical as productivity. Without productivity, we have nothing, in terms of the company, in terms of the nation, in terms of the family. We have to achieve productivity. We have to work together. I know I'm waving a flag, but I'm being a realist. And to sit down and negotiate an agreement, a labor contract, with an organization that is rooted in politics, as every labor union is and must be, in terms of structure of unionism in the country, just suggests to me - and it should to you - that sooner or later there is going to be a trade-off and the trade-off will be that in order to get something else, the productivity issue will suffer. That shouldn't be. So I implore you, if I may - don't ever consider the concept of negotiating for productivity.

I do submit to you, however, that labor unions in 1980 are becoming more sophisticated on the subject of productivity and less concerned about their so-called union rights and protecting the interests of employees, by being receptive on a reasonable basis to productivity initiatives advanced by management. And that lies outside of the collective bargaining process and it can be done - it is being done. But you have to do it with great sensitivity.

So don't give the store away in order to get the union in your camp. Again, it can be done. And don't go for the people who tell you that the way to do it is to sit down in Washington and negotiate productivity agreements with the union leaders there. That will get you nowhere. And don't sit down on a

reasonable basis and do it, either. That will get you nowhere, because a labor union, like a church or like a PTA, is a highly politicized organization and the people in Washington and the people in Atlanta and wherever the regional area is covering Jacksonville, they don't have the power today to tell the local unions what to do or what not to do. So you have to go through the musical chairs in working with the regional union groups, but that's just for them to be convinced you're not a commie and you're okay, you won't hurt them. But the deal you have to cut in working with a local union on an employee involvement program, whatever it might be, has got to be with local people. And there you have to be very careful. I've never seen a local union yet where you don't have the in's and out's - you negotiate a deal with the in's and you find out a year later that the out's have come in and they will reject the program because you negotiated it with the other group. You have to be awfully, awfully careful with that. But it can be done.

Some companies, however, are finessing that, they think. They're not doing that. And they're surviving for the moment. I submit, these are the ones who will go down the tube.

Now, there is a distinction in the labor agreement between the private sector and the public sector. As we know, in the public sector, the guts of a contract, the economics, is not negotiable. That's taken care of by your Congress and mine. In the private sector, in contrast thereto, the economics are negotiated. So in one sense, it may be more difficult to work out a union concurrence with an employee involvement program because you're not negotiating on economics. On the other hand, I think it can be done with equal facility in the private sector as well as the public sector if you recognize the political needs of the union you're working with. You must absolutely recognize their political needs. They're going to talk to you about the fact that they're representing the health and welfare and interests of the employees, etc., etc., and sometimes they mean it. But for the most part, they're looking at it through their political prisons and you have to look at it the same way, and understand what their needs are and address yourself to those needs. Then you can work a deal and it won't really cost you anything. Remember, they've got a place in the sun - they've got dignity - and above all else, many of them want to be re-elected. That's the key to it. You've got to make sure that what you work out with them will not impair their opportunity for re-election.

In the interest of time, I'm avoiding some details as to how this can be done, although I understand we're going to have time available for questions and answers, and I'll be glad to address myself to those, if you have any. Or again, if you'll buy me a drink, I'll talk to you for days. Thank you.

Dr. Shipper

It would appear that we're picking up speed and I hope we're picking up interest.

The last speaker is a person who has dealt with this at the very local level. He is Elbert Newton. Some of you may be acquainted with him. His current position is the Civilian Personnel Officer at the Naval Air Station, Cecil Field, Florida, which I understand is across the bay.

In the past, he has been in the Navy and is a Navy veteran. He has also been a Personnel Assistant at Dahlgren, Virginia, Naval Weapons Laboratory. He has been the head of the Wage and Classification Branch at Quantico, Virginia - he deserted you for a short time and became a Marine. He has been the director of the Employee Relations at Charleston, and at Charleston he was also the head of the Employee Relations Division. So I would like to give you Albert Newton.

Mr. Elbert C. Newton

Herb and I had a little discussion yesterday on the phone and, as usual, those consultants always sabotage you. After we talked it over, he covered everything that I was going to cover. But that's typical.

Basically, though, I would like to share with you at least a few thoughts that I have in this field, from my experience in the Federal sector, and I know that we have a lot of private industry folks here, and I know that some of you have probably said that you've been putting up with this for 40 years, what's new about it. Since 1962, roughly, we've been putting up with certain things in the Federal sector. We weren't sure what it was at times - we weren't sure where it came from, at time - and we weren't sure where we were going at times. But finally, about 1978, Congress got together and said, similar to what was done in the private sector many years ago, that there is a statutory protection for Federal employees to organize and bargain collectively. The law and it's background, interestingly, provided that certain things were applicable. It said this protection safeguards the public interest, contributes to the effective conduct of public business, and it facilitates and encourages the settlement of disputes concerning conditions of employment. But it made an additional finding that the public interest demands high standards of employees' performance. What interest does the union have in employee performance as contrasted to who is going to be responsible for that? Also, that the development and implementation of modern and progressive work practices is important in the Federal sector. Again, who is responsible for that? I can assure you the unions are

not necessarily interested in it where there is elimination of jobs.

We can say all we want to about what has happened in the past - in the private sector and public sector. The union is interested in protecting every job that it can because it represents again the political aspects that Herb mentioned - the potential for membership and the potential for the dues and the potential for political clout that goes along with that. Of course, the law goes into a great amount of detail and I don't intend to get into that portion today about setting the minimum standards of how this relationship would occur and in what way it would be carried out, and who is responsible for the various parts of it. But I think that the Congress also, with this statement of public interest, demanded an accounting for an effective and efficient government. The fact is, that's stated in part, that "this law shall be administered in an effective and an efficient manner." There, I believe, that the law represented additional kinds of restraints on Federal managers, but it also mandated that labor relations management or the management of the labor relations program itself, must be productivity-weighted and that's what was expected of management in the process.

As we talk about labor relations, if you read the literature sometimes you're talking about the management-employee relationship; if you talk about union relations, you're talking about the management-union relationship. And I think we can separate the two and yet deal with both of them. We have to be concerned about our employee-management relationships in our productivity effort and in our day-to-day work, and I think that is sometimes where we break down a bit and hurt our unions. But when you do have that form of relationship, the only thing in the Federal sector, as was earlier mentioned, that we can bargain about is predominantly work rules...fringes, wages, insurance packages. A variety of that kind of thing has been set by Congress and we don't have much flexibility. So what are work rules in the Federal sector? Those things that concern personnel policies, practices, and matters that otherwise affect working conditions. They gave them everything else to deal with in some fashion or form.

Most of our major items on these things are the local circumstances at the command level for most of the Department of Defense. There's a lot of delegation, decentralized management. A variety of issues there that can impact on productivity really create issues that are a challenge to us to resolve in a labor-management relationship primarily to avoid an erosion of productivity, because the more work rules that we establish, the less flexibility we have.

Another concept we might have here is that it's not so important what you agree to do as to whether management has an effective control over it. If you agree to do something, it may not be bad. But if management totally gives up control, that's probably worse than if you had agreed to give them even more.

Be aware that no manager can know the entire scope of labor relations....with a few exceptions. We have some exceptional people that have a real good impression. But managers must learn, in my view, the basic and fundamental impact of managerial decisions in the labor-management relationship when we do have that union. And we must accept certain fundamental processes to follow when we implement our productivity initiatives. If you don't have a union, you can deal in a different kind of way with your people, but when you do, as was mentioned earlier, there is a very important step at some point in the process, and an obligation, that if it has an impact on some of these operational personnel policies, practices, or working conditions, that we deal with the union in a very positive manner. It may be, for example, that a productivity initiative could be started with respect to a change in shifts. A very simple thing. The Commanding Officer says, "Change it." That's his first mistake. Because you cannot make a unilateral decision and if that doesn't affect personnel matters or a practice or a working condition, I'm not aware of any case that has been sustained for management to say that they had the right to make that unilateral decision in our arena.

The point is, the same thing can usually be achieved if we spend a few extra minutes or a few extra hours and follow some certain procedures that we have set in place under the statute to move it. To do that, you need some staff people who will give you the kind of support in labor relations itself, a labor relations manager or a personnel manager with labor relations experience - someone who can provide the managers with the information that they need to carry out their basic responsibilities and help them get there to make those decisions that would improve that productivity's need.

In the Federal sector, we have a tendency, also, to look at certain matters as being always within the scope of the top manager. The point is, I think that we must assure that some of these representatives who represent us in these special interest groups not only have the expertise to help you achieve what you want to do as a manager, but also must have the authority to go along with that and to deal with the management team with reasonable responsibility when they're dealing with the union. And then be held accountable. To many times we say, "It's your responsibility and you have the authority to go with it," and when the guy gets through with you and he sold you out to the cleaners, you haven't held him accountable for

what he's done, or you haven't held the foreman accountable for what he's done. You tell him what he has to do and that he's responsible for it, but you don't hold him accountable. That's another part of this particular area that's important.

You must set some realistic goals in your collective bargaining process in the Federal sector. It's very important for us, because we do not have the packages to deal with in terms of money and incentives, and so forth.

So the union comes in at the local activity to pick us apart on little things that create administrative impediments, administrative minutia, in some cases. So we must be concerned with that kind of thing and sometimes, I've found, from talking to colleagues in the private sector, that that is sometimes more difficult to deal with than having that package down here somewhere that this is what they want and this is what I'm holding out for until I resolve some of these issues, and this is where I can deal with a particular process.

You have to set up artificial bargaining processes, almost, in the Federal sector to achieve very similar things.

I don't want to take a lot of your time, as we run near the end of the day, but I would like to give you some guidance as I see it that managers in the Federal, as well as the private sector still do. Executives and managers and first-line managers must continue to be updated, basically, in the application of practical case law. Don't try to make everybody an instant expert in labor relations. That's what we do too often. You've got specialists around here, in the Navy, in particular. You've got a systematic approach. You've got your own staff specialists, you've got regional specialists for certain things, and you've got the Headquarters specialist. So there are some highly specialized areas, and that's where you need to call for that help. But maintain some local professional types of staff for yourself, to answer those questions - who know what's going on in your organization. Don't minimize those resources. Don't put on who is available. A top management representative handling an arbitration case that may be important as far as what your contract concerns - let me give you a horrible example of an application of this.

I know of an activity that put a management rep on an arbitration case and the burden of proof in this particular case happened to be on management. All he did was argue. Never put on any evidence. Never called a witness. Never introduced a document. Guess who won that case and what kind of precedent it might have established for that particular contract. He didn't know what he was doing. I have to be honest with you - sometimes you'll get labor specialists who don't know it either,

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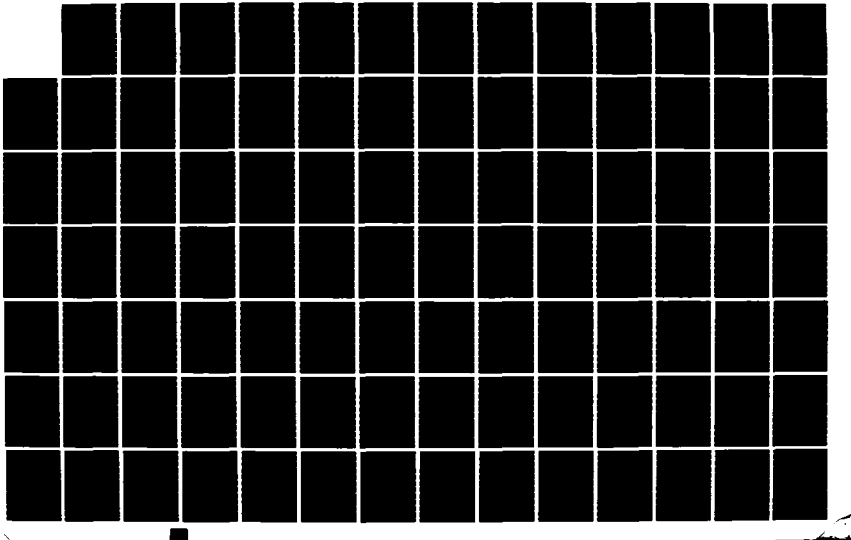

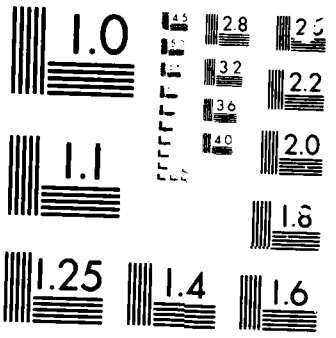
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but at least you'll have a little bit of an edge if you get someone who knows about the process. You've got to keep current on the changes in the case law. In the Federal sector right now, we are about, in case law processes, where the private sector was, I would guess, in 1951. And that's just a rough guess. They had about eight years at that time. We've got about eight years under executive order and about four or five years under formal third-party proceedings, such as the National Labor Relations Board - not quite the same process.

A building burden of case law is coming along, and you don't sit down and distribute those to every manager and make him an instant expert. The volumes are growing at the rate of eight volumes last year, and this year we're probably already up to the third volume for 1981.

Have some ready assistance to your managers and supervisors. Be prepared to preserve and defend your management responsibilities. You've got rights. But we're not talking about rights. I know what our rights are. You know what your rights are. What we're talking about is management responsibilities to defend ourselves in those cases where we need to.

We have to assure a business-like and respectful attitude toward the union - there's no question about that. We have to recognize the political aspect, there's no question about that. And we have to recognize in some way to solve that political need by, in many ways, that communications effort to fulfill our mission and to assure the productivity that we have or the initiatives that we have going do not get eroded by improper handling of our labor-management relationships.

I think it's time for cocktails. Thank you.

SESSION III

PRODUCTIVITY TECHNOLOGY

Session Chairman: Dr. Lemmuel Hill, Technical Director, Office of Naval Technology, Washington, D.C.

First Speaker: Rear Admiral A. J. Baciocco, Jr., Chief of Naval Research and Chief of Naval Development/Deputy Chief of Naval Material for Technology

Admiral Baciocco

I'd like to discuss with you today the ways we see technology leading to productivity growth.

There are three major factors that lead to productivity growth - technology, people, and capital. We in the Navy are vitally concerned about the first two factors. Economists agree that the most important source of productivity growth, accounting for more than half the net growth between 1948 and 1977, is attributable to technological advances. Technological advances lead to better machines and new products; however, it takes highly trained and motivated people to run and maintain these machines. The Navy relies today on advanced technology and highly skilled and motivated manpower more than ever, and we see our concerns in these two areas leading to the requirement not only for a more productive Navy, but also for a more productive national economy.

By now, this nation's decline in productivity growth cannot be news to any of you. A recent study by the New York Stock Exchange Office of Economic Research states that from 1967 to 1977, our productivity growth was 1.8 percent per year, as compared with 3.3 percent during the previous 20 years. Not just coincidently, the study noted, R&D expenditures also declined from the mid-1960's through 1977. The Stock Exchange report concludes, among other things, that incentives to spur research and development should be considered among our most urgent national priorities.

Of course, the fact that the growth rate of our technological knowledge has declined, does not mean that our knowledge has similarly declined. On the contrary - despite the leveling trend in R&D expenditures, significant advances have been made

in several fields that hold tremendous potential for a return to an impressive productivity growth rate. The most dramatic of these advances have occurred in the areas of electronics and computers. Such advances have given rise to the potential for substantially extending human capabilities to perceive and assess information, to make decisions, to perform work. The term "articial intelligence" (or A.I. for short) has been applied to this technological discipline, the practical applications of which can have dramatic impact on our productivity. Not only can A.I. increase productivity directly through complete automation of certain selected functions, but it can exert a leverage effect on human productivity so that, with man in an A.I. loop, a 1 percent increase in man-hours worked can result in a greater than 1 percent increase in output. Let me describe a few recent results of R&D in this field and suggest how they might be utilized.

Artificial intelligence research has focused on the design of "smart computer systems" with such capabilities as: (1) machine acquisition and representation of world knowledge, i.e., understanding meanings and relationships across human discourse, objects, events, and abstract concepts; (2) the provision of automated techniques for performing intelligent functions, i.e., data filtering, data abstraction and summarization, drawing inferences, and making deductions; and (3) exploring the potential of machines to perform multi-sensor integration, to recognize impending crisis situations, and to sound alerts or alarms prior to their occurrence, to detect and correct system errors and anomalies, to accommodate and adapt to change, and to provide a corporate memory of past decisions, decision consequences, and rationales. Furthermore, the addition of sensing and reasoning capabilities to manipulators has resulted in a new class of systems called intelligent robots. These may be employed completely autonomously, to increase output rate in repetitive operations such as assembly lines, or semi-autonomously, in cases where human judgment is desired to avoid serious error or to exert supervisory control.

Based directly on technologies growing out of artificial intelligence research, experimental machine systems have been developed which provide medical diagnosis and treatment recommendations in several disease areas. Automated systems have been designed for organic chemical synthesis, and for inferring chemical structures. Systems have been built which demonstrate machine capacities for understanding human speech about restricted domains of discourse, and for answering data base queries posed in natural, less than perfect grammatical English. A.I. techniques have been developed for the design of VLSI components.

Advances in the above areas are, of course, highly dependent upon continuing rapid progress in the development of microelectronics of unprecedented capability at reduced cost. In the

near term the DOD Very High Speed Integrated Circuits (VHSIC) program promises both quantitative and qualitative advances in military capability and can ultimately have significant impact on industrial capability, as well. Looking further into the future, the Navy Ultra Submicron Electronics Research Program addresses the microelectronics generation beyond VHSIC with still higher density and speed for the microelectronic building blocks, with greater capability per chip, and with robust, fault-tolerant, self-diagnosing circuity. Parallel advances are underway in superconducting electronics, a more revolutionary approach which makes use of ultra-high-speed Josephson Junction (JJ) technology. Taken together, these ambitious developments will usher in a new era of abundant, economical, and versatile memory and processing capability.

Productivity can be enhanced by advances in a number of other technologies. For example, new materials can provide entirely new capabilities as well as providing substitutes for more costly materials in use today. In this regard, one of the most exciting new materials classes that Naval Research is investigating is conducting polymers. Conducting polymers may bring about new capabilities in electrical power generation and in lightweight electric vehicle technology, thereby increasing overall national energy productivity.

Advances in systems analysis technology can improve total productivity by understanding how people, machines, material, and information fit together and interact with each other. Development of complex state-of-the-art machines to carry out a single function in a multi-function process can create bottle-necks rather than improve productivity. It is important that a systems approach be utilized to provide the correct amount of information or material in a timely manner to either the people or machines for carrying out the assigned function or adapting to a new situation.

A discipline which partially bridges A.I. and human factors concerns in order to improve productivity growth is "precision engineering." Its pursual in an integrated fashion has long been neglected in the United States, yet its approaches can lead to innovation of a special kind - doing "it" right the first time and every time. The "it" is manufacturing and measurement, especially for high technology areas, where accuracy means so much for success in performance and in the marketplace. Activities as diverse as single point diamond turning of reflective metal optics, production of VLSI circuits, and ruling diffraction gratings all depend upon achieving the highest levels of precision in manufacture and measurement. This concept of precision underlies many aspects of machine design and production technology, as well.

I have discussed how advanced technology in a number of areas can contribute to efficiency. There are other technologies that can contribute to training and education, and to health, all of which contribute to improved productivity. There are technologies from the behavioral sciences that improve our understanding of motivation and managerial effectiveness. Ultimately, we must rely on people - primarily on managers - to support the R&D needed to develop these technologies, to recognize the situations that could benefit from their applications, and to introduce them with a great deal of sensitivity regarding their impact on, and acceptance by, the workforce.

How do managers risk jeopardizing the benefits that are promised by these high technology systems? How can they avoid these risks?

First and foremost, managers can jeopardize the increased productivity by not recognizing the potential benefits offered. Only by widespread awareness of the accomplishments already achieved, and imagination to visualize applications to new situations, will the necessary support be assured for continued R&D in these vital fields. Of course, the R&D must be rational. Advances in the technologies themselves must be accompanied by careful experimentation to measure the changes in performance of the man-machine systems in which they would be embedded. And reasonable estimates must be made of all of the costs involved: development, production, and life-cycle, including the costs (or possible gains) of retraining personnel to perform new and different functions in these new systems. In other words, the technology development must be accompanied by generation of the cost-benefit data needed to guide rational implementation. We must know where to apply these new techniques to ensure fulfillment of their promise.

Secondly, their implementation must be carried out with full participation of worker organizations. Most people fear innovation because it is fraught with unknowns. Workers can find many ways to make sure that unacceptable innovations perform poorly. They must be in on the planning and feel that they have participated in the decisions, if the new technologies are to be accepted. Innovations should not be forced on an organization before both the technical and human bugs have been worked out. I'm sure you are all aware of the serious maintenance problems we face because the complexity of our new systems exceeds the capabilities of our people to keep them operating. This is a multi-faceted problem with no simple solution, but the message here is that implementation must be sensitive and patient or it can backfire.

High productivity requires that managers be considerate of the feelings and values of the people they supervise. One of the most important functions of a manager is to foster high motivation. Yet, studies have shown that managers tend not to understand the motives of their subordinates. One recent study by Kovach, published in Advanced Management Journal in 1980, showed that in some ways the things employees value have changed over the last 25 years. For example, of 10 factors ranked by employees as important to them, "interesting work," which was ranked 6th in 1946, rose to 1st place in 1980. "Full appreciation for work done" remained about the same, first in 1946, second in 1980. But the interesting thing is that supervisors consistently misjudged what their employees valued. They thought employees valued "interesting work" fifth in both years, and "appreciation for work done" eighth in both years. This does not bode well for the motivation needed to ensure productivity.

Comparisons have recently been made by Bill Ouchi of UCLA between Japanese and American organizational characteristics, in an attempt to understand the differences in productivity growth. Many differences were found. Ouchi does not contend that we should convert to the Japanese style in order to compete more effectively. But he has identified one important difference that seems to underlie many of the others. It is probably based on deep differences in culture, but if we understand it, we might be able to modify some of our managerial attitudes that are now discouraging high motivation. The difference is that in the Japanese culture, the objectives or goals that are set, and against which people are evaluated, are long term, while in the U.S. they are short term. Frequent job rotation across organizations by managers (and employees) in this country encourages the attitude that goals must be achieved within a managerial "watch" that can be as short as two to three years. In Japan, employment in a company is frequently for almost the entire working career, and the time span for achieving objectives may be as long as five or ten years.

Clearly, our cultural differences are too great for us to adopt the Japanese style. But for many reasons, it behooves us to remember that there is much to gain by taking a longer-term view. Our sense of perspective, our ability to understand and consider the feelings and values of others, even our assessment of our own productivity growth rate, would be benefited if we stopped demanding immediate profits at the expense of long term growth.

I've told you my views today on how technology can lead to productivity growth. New technology in the fields of electronics, computers, materials, and others, along with enlightened management, all play a role. We in the Navy view

productivity growth as a crucial element that will allow us to carry out missions within a scenario of shrinking manpower; we are keying much of our research to that end. Industry, for their own long-term interests, would be wise, in my view, to invest further in basic research and development. There's a short-sighted tendency right now among many in industry to work primarily on product development for short-term financial gains.

Finally, new technology should not be viewed with suspicion, as many tend to do. However, development and implementation of new technology, which can and must lead to productivity growth, should be done with care, keeping the human role in the system in perspective.

Thank you very much. If you have any questions, I'll be glad to try to field them.

Question

How do you define productivity for the R&D organization that you're in charge of?

Admiral Baciocco

I'll add first, the productivity I'm talking about today is not the productivity in my R&D organization, but rather that of the Navy in general and the industry that supports the Navy.

It is difficult to quantify in an R&D organization. There's no single measure. We have the rather simplistic methods of looking at the number of contracts, size of contracts being handled by various scientific officers. We have a separate system to look at the technical excellence of what we're doing, whether through a peer review scheme or a corporate management technical review. We really, when you look at the R&D organization, for instance, my ONR hat, 80 percent of what we do is contract research at universities, I'm really trying to measure the productivity of the researchers that I'm hiring, so to speak, under contract. That is done by publications, their reputations, and how productive, if you will, the results of their research is toward the goals of the Navy. There is no easy way to do it - and I really can't answer your question very well.

I don't think it's right, in research and development, to be purely mechanistic in measuring productivity. There's got to be a lot of intellectual understanding that goes on and it comes from having good people like Dr. Hill and Dr. Smith in my ONR side running the organization for me and with me.

(Question is unintelligible.)

Admiral Baciocco

Failure is really a measure of progress and, thus, success in basic research. I've stated this not only publicly within the Navy, but also at academia, and it's also in my written policy, you've got to take risks. Just because you fail doesn't mean you've done a bad job. Too often we get very conservative. No one wants, particularly in the bureaucracy in which we live, people tend to try to pick a winner, and thus get very conservative in what they're doing. I think failure - as long as it's not 100 percent failure - is a healthy thing.

Question

Are you doing anything to simplify the proposal process?

Admiral Baciocco

The question relates to the bureaucratic delays that often occur in the review and ultimate funding of research or technology proposals. Over the last three years at Naval Research we have worked very hard to try to ensure that the time it takes to process proposals mechanistically is as short as possible, and intellectually is as fair and as short as possible. We've done a number of things. First, we put in a planning program and budgeting system, a PPB process not unlike that which is in OSD, not to bureaucratize but to try and encourage the scientific officer to plan ahead on what he wants to be doing so he can be talking to his potential principal investigators, not only what they want to do next year but also what they ought to be thinking about in future years. It doesn't mean we're planning research results. We're not. We're planning where we want to go - we revisit that every year and if the opportunities change, if the needs change, we'll zig. The point is, though, through this process not only does the scientific officer, the key man in my organization, have a commitment for me that I've got dollars programmed, but he's got the confidence that he can go off and talk realistically to a laboratory, to a university, and know that he's got the dollars in his pocket to work in an area with the full support of Department of the Navy management. We also have created a series of types of programs - one we call Selected Research Opportunity Program, which I started in 1979, which, instead of being a one-on-one type of thing, scientific officer to principal investigator with, over the years, the number of contracts increasing and the size of contracts going down so I was buying a fraction of a professor's time, this was a program whereby I came up with some areas of interest to the Navy and then solicited university and industry for research proposals which would be of the order of $300,000 to

$500,000 a year with a three to five year duration. We had a tremendous response to that. Once you get through the wicket - the review is tougher, but basically we handled the whole cycle inside of about 3-1/2 months, very much geared up to it and once someone was on with that, basically they had three to five years, depending upon what they proposed, of funding with their graduate students in a critical mass sort of affair. It eliminated much of the bureaucratic delays. I think we've done well, but then, I'm biased, because we've worked very hard at it.

(The remainder of the questions and answers were not recorded.)

Mr. Nick Yaroshuk, Westinghouse Electric Corporation

Good morning. It's a pleasure to be at the Defense Preparedness Association to talk about one of my favorite subjects: robots. To say that the field of industrial robotics is fast moving is decidedly an understatement. I've witnessed the phenomenal interest that robotics has generated - not only in the manufacturing disciplines but in the entire business and financial community, to say nothing of the general public. Robotics is an idea whose time has arrived.

This arrival is the result of two trends: one up and one down. The up-trend is the phenomenal increase in cost-effectiveness of the robot's control system - the microprocessor. The curve of solid state technology, benefits-per-dollar spent, has risen faster than the space shuttle.

The other trend line is a downward one. That line is the productivity improvement of this country when compared to our competitors.

Robots are one of the answers to productivity improvement, and industry in this country needs answers. If I may, I'd like to reflect for a few minutes on the state of industrial production in the U. S. To show where we've been and where we are now, I'm going to use three automotive examples: one from the U. S., one from Japan, and one from Europe.

The first example deals with the birth of mass production, and it shows how, in the past, the U. S. set the pace in leadership and innovation in manufacturing.

In 1913, Henry Ford introduced the conveyor assembly line using interchangeable parts. Compared to shop assembly using custom made parts, this method was a quantum jump in manufacturing technology. The conveyor assembly line represented a fundamental change in the way things were made. By 1914, Henry Ford was building Model-Ts at the rate of one every 90 minutes. During the 19 years the Model-T was produced, 15 million were built.

Ford's introduction of the conveyor assembly line had a dramatic impact on product cost. It was possible for Ford to cut the cost of the Model-T from $850 in 1914 to $400 in 1916. Clearly, the age of mass production had arrived.

The Model-T is a good example of the kind of ingenuity and entrepreneurial spirit that ushered in a golden age of manufacturing in the United States. We were to be the dominant force in industrial production for the next 50 to 60 years.

However, when we look at the current state of manufacturing in the United States, we can see dark clouds on the horizon. Our

competitors, the other industrialized nations of the world, have been studying our techniques, and they've learned their lessons very well. This is a critical period. Fewer cars will be made in the U.S. this year than in 1955. More than half of our exports to Japan are food, fuel, crude material; more than two-thirds of our imports from Japan are finished, high technology manufactured goods. The U.S. leads all other industrialized nations in the size of its trade deficit, the number of workers unemployed, the number of large corporations fighting for their lives.

The automobile industry has become a microcosm of the problems plaguing U. S. manufacturing. While we're still the most productive nation in the world, if things keep going the way they are, the U.S. leadership in manufacturing will be overtaken by Germany in 1984 - France will catch us in 1985, and Japan in 1992. Now those Japanese figures are a bit misleading because in some key industries - particularly steel, automobiles, and home electronics - the Japanese already have passed us.

There is no question about it. This country's position of unquestioned superiority in manufacturing has been eroded badly.

My second example relates to Japan. We'll see some of the reasons why the Japanese have become a potent force in manufacturing. To show you how effective they've been, I'd like to use some statistics that indicate the phenomenal growth of the Japanese auto industry. In 1965, the U. S. market for cars and trucks was 10.9 million units. Of the 5.4 percent that were imports, only .2 percent were Japanese. Of course, the auto industry is important to all of us. It accounts for one out of every six jobs in America's basic industries.

In the 15 years since 1965, the Japanese have increased their share of a 14 million unit market to 22 percent, a 100-fold increase. Stated differently, the Japanese have captured 85 percent of the entire growth in the U. S. car and truck market in the past 15 years. One-half of the cars that leave showrooms in California this year will be imports, mainly Japanese.

Of course, many factors have influenced this amazing market penetration - oil prices, international trade tariffs, and product planning. But I'm going to focus on one of these factors -- the use of robotics.

During my last trip to Japan, I saw a multitude of examples that show why the Japanese are the dominant force in robotics in the world. The Japanese have over 11,000 robots currently in use according to a Robot Institute of America survey. This represents 61 percent of the world population of robots.

What astounds me, in addition to the tremendous investments they've made in new plants and equipment, is the tremendous determination and dedication that drives everyone - from a factory assembler to their top executives. Their factories are clean -

incidently, clean factories and quality go hand-in-hand. They are determined to be number one - to out-perform anyone in the world in terms of cost, delivery, and quality.

There is a substantial commitment to robotics and automation in general on the part of industry and government. The relationship between government, industry, and labor in Japan is one of amicability and cooperation. The Government Ministry of International Trade and Industry not only conducts research and development in robotics but also works with industry in robotic applications.

Toyota is typical of the Japanese approach to relentless productivity improvement. Although I'm dealing chiefly with robotics, Toyota improves productivity in many other ways, including inventory control, quality control, and worker participation. Toyota is a leader in robotics in auto manufacturing. At the Toyota Kamigo engine plant, there are some of the 200,000 engines manufactured there each month. They also make 80,000 transmissions per month.

Kamigo has a completely automated engine manufacturing facility, except for final assembly and operational testing. In addition to hard automation, they have 800 robots. In the entire 1 million square feet of plant, there are 100 people per shift, 30 of which do maintenance. Flexible manufacturing allows Toyota to carry a fabricated parts inventory to supply about three hours of production.

Another example of extensive use of robotics is the Toyota Zama assembly plant. Two hundred robots are currently in use spot-welding auto and truck bodies. In the next several years, Toyota will install 720 additional robots at Zama. The factory will have over 900 robots in March 1983, making Toyota the biggest user of industrial robots in world auto production.

The Datsun Zama plant in Tokyo produces the Datsun 210 and the 200 SX, with 95 percent of the welding done by robots. Over the next several years, the number of robots will increase dramatically. Most body parts are loaded on-line automatically. Datsun Zama's performance is the result of automation and skillful use of its personnel.

But perhaps most important of all, the Japanese don't employ the NIH principle - Not Invented Here. The Japanese have stated that the gains they've made are the result of careful study and diligent application of techniques learned in the United States and elsewhere.

Here is a slide that typifies how open the Japanese are to the ideas of other countries. This photo was taken on the streets of Tokyo. In the foreground is a VW Rabbit from Germany. On the first floor of the building is the largest McDonald's in the world, and on the second floor, a Pierre Cardin clothing store from France.

My third example shows that the Japanese have no monopoly on aggressive innovation in manufacturing. Let's take a look at Fiat's Turin assembly plant in Italy. This plant makes the Fiat Strada, a subcompact. Fiat uses a vast and complex system called Robogate. Developed by Comau, an automation company and robot builder, the Fiat robogate is perhaps the largest robotic installation in the world. Fiat owns controlling interest in Comau. The Fiat plant assembles 1,100 cars per day with a work force of 150 workers. There are two elements in the robogate system. The carriers, or chariots, move the car bodies around the plant. The bodies are moved through a succession of robotic work stations that perform welding operations on the body. The robogate system replaced the standard gate system employed in most auto assembly plants.

In the robogate, all the bodies on a particular line are routed through one large tooling machine. The advantage of the robogate system is dimensional accuracy from one body to the next. Robogate locks up each body the same way and establishes dimensional integrity consistently. Another big advantage is realized during model changeover. This process, which normally takes from two to six weeks, can now be done in several days. Switching between the two- and four-door models can be done in a matter of minutes.

The important point is that companies in the U.S. that try to make do with the tools, methods, and processes of even the recent past are in for difficulty in the 1980s. We may have invented mass production, but we've got no patent on it. If this country is to be a leading power in industrial production in 1990, many robotics programs in many companies will be required.

At Westinghouse, we've got an active robotics program and a commitment from top management to expand and accelerate robotics at Westinghouse as fast as practical. In the past 14 months, over 50 robotics applications have been developed for a whole range of welding, painting, and material handling applications.

Our Applications Engineering group helps Westinghouse divisions design, build, and install robotic manufacturing systems. The Development Engineering group is working on adaptive parts assembly systems and vision systems. We also have a large robotic laboratory for testing robotic systems prior to factory installation and also for testing various available robots against vendor specs.

In addition to our robotic applications and development projects, we are affiliated with the Robotics Institute at Carnegie-Mellon University, which Dr. Reddy talks about at length.

Before showing you some specific applications of robots at Westinghouse, let's look at what robots are and how they improve productivity.

Robots are commercially available in many different configurations with attributes suited to particular kinds of jobs. Robots can be differentiated in three ways. The first is degrees of freedom or the number of axes of movement. The second way of differentiating is by control mode - the method used to record and play back movement commands. And the third differentiation is the power source for movement of the articulated sections.

There are two general types of robots. The first, called limited sequence robots, are smaller in size, lifting capacity, and memory. These robots are typically lower in cost (on the order of $5,000 to $10,000). Programming involves setting mechanical stops and limit switches. Another characteristics of the pick-and-place robot is very accurate positioning. It is air operated and has limited lifting capacity.

The second type is the computer-controlled robot. Within the class of computer-controlled robot there are two basic kinds; the continuous path and the point-to-point. Here is an example of a computer-controlled, continuous-path robot. This is the T-3, made by Cincinnati Milacron in the U.S. It has six axes of movement and is controlled by a computer which can program a large number of points within its sphere of operation. The power source that moves the articulated sections is hydraulic and it has a lifting capacity of 120 pounds. Priced at from $85 - $100,000, the T-3 is an example of a high capacity, complex industrial robot.

Here is another computer-controlled robot but of smaller size. Made by ASEA, in Sweden, it has six axes of movement and its joints are powered by individual electric motors. Continuous-path robots like the T-3 and the ASEA are used for tasks like arc welding, grinding, and applying adhesives.

This is the Unimate, made by Unimation in the United States. In its most basic form, it is a point-to-point robot. The Unimate is used for spot welding and material handling. Point-to-point robots require less memory capacity and are capable of faster movement.

At the end of a robot's arm is not a hand but a "gripper." The design of the gripper is really dependent on the specific application of the robot. But generally, grippers use mechanical clamping, pneumatic suction, or magnetic force. Special purpose devices can spray paint, arc weld, or spot weld.

Now that we've taken this brief look at robots, let's turn our attention to how they are incorporated into the manufacturing environment. This process of integrating robots into useful systems to perform work is called "robotics."

It is possible to buy a robot off the shelf. It is <u>not</u> possible to buy a robotic solution off the shelf. The process of integrating a robot into a manufacturing environment relies on a

systems approach to applications engineering. A robot's real worth can be exploited only by careful design of the peripheral equipment around it. In complex robotic projects, applications engineering and the building, testing, and installation of peripheral equipment can typically be 75 percent of the total cost.

Applications engineering often means rethinking the relationship between the workpiece and the worker (now a robot). Robots operate with very tight dimensional constraints. The design of parts presentation devices and jigs and fixtures must take these dimension constraints into account.

From a technical standpoint, industrial robots have some interesting qualities. They are modular, ready to use, highly programmable, and reprogrammable. But how do they increase productivity? One way, of course, is by the replacement of direct labor. Especially in multi-shift operations, the payback for robots is very attractive.

There is a two-fold productivity improvement realized by displacing the human worker. First, the robot is able to shoulder the burden of hot, heavy, hazardous, or monotonous tasks. This, then, releases the human worker to do the jobs which utilize the mobility and intelligence of man.

But other cost-reduction opportunities arise when humans are taken out of the picture. Robots can affect peripheral factors in manufacturing that result in savings in material and process costs. A good example is the painting robot. When people are spray painting, the air must be kept free of solvents and particulates. With a painting robot, it is possible to reduce the exhaust air volume by 50 to 60 percent. This reduces the energy requirements and capacity of both the factory's heating system and the paint spray exhaust system. Users of painting robots report a reduction in paint usage of 25 to 50 percent due to more precise control of the spray pattern.

Another area for productivity improvement is increase of product quality and reduction of scrap and rejects. Painting robots, once taught the sequence of painting a part, will repeat that pattern, precisely, every time.

So we see that robotic systems improve productivity in three ways: by reduction in direct labor (while better utilizing human workers); by reducing material and process costs; and by increasing product quality.

In conclusion, I'd like to thank you for asking me to participate in this symposium. I've tried to suggest that there are a number of urgent problems to be addressed by the manufacturing disciplines if this country is to maintain a leadership role in the world. And I believe that robotics will play a prominent role in finding solutions to those urgent problems. Thank you.

Dr. Raj Reddy

(The introduction of Dr. Reddy and the beginning of his presentation were not recorded.)

Every factory that is being planned, it would be foolish for the factory designers if, in addition to power cables and air pressure and other kinds of cables, they don't also have an information cable. What might this be? I don't know, but any number of possibilities exist. The simplest one is some kind of broadcast network that many of the computer companies are now beginning to develop, or any number of other solutions. Whether they are optic cables or coaxial cables, it doesn't matter. There must be an information cable.

Number two, we must begin to develop smart sensor technologies. Not only is it important to have sensors that can sense every aspect of the whole package, but you must add intelligence to the sensor, if you will. What that might mean we will come back to in a minute, but without that type of sensor, these current systems will get completely bogged down.

Number three, we need some concepts of intelligent motion. You've seen the robots making various operations. If by chance any obstacle comes in the way or if you have to avoid an obstacle because two or three systems are interacting with each other (it's not the case that almost all the tasks we want to perform can be done by a single robot; there may be multiple robots doing things), and it's not always possible to prearrange everything, to preprogram so that everything is going to happen perfectly. It must be possible for you to deal with obstacles and systems that can have intelligent motion. For example, in robotics laboratories around the country, the simple concept of a continuous motion, where you can move in a straight line, where all the joints are moving, has taken a number of years to develop. It is not always possible. Most systems today will move in the "X" direction and then in the "Y" direction, and then in the "Z" direction, and then perhaps rotate one activation at a time, partly because the microprocessors that were controlling were not fast enough to do all of them at the same time. However, it may be that such a motion will lead to some obstacles. It is not to say that there may not be some other motion which would have led you there without any difficulty at all. Assembly and inspection in areas which are fairly tightly constrained, where people can put their hands in and do operations, are the kinds of things that are impossible for most robots to do today. It is not simply a question of programming them, because people

don't know how to program them. You can't just lead them by the nose, either. It becomes a much more interesting intellectual problem and these problems are solvable, but is requires systematic attention to the details.

The last, but not the least, is what you might call intelligent logistic support. This leads me to the white collar robotic area; namely, the whole issue is not simply a question of replacing or improving the productivity of blue collar workers, but also all the white collar workers in the factory. It turns out that approximately one-third of the workers in a factory are white collar, but the salary cost of this one-third is over 50 percent. Insofar as we can improve their productivity, you will be doing the same kind of goodness as improving the total productivity of the factory.

What do I mean by smart sensors? By smart sensors, I mean sensors which can do intelligent interpretation of usually voluminous sensor data in the presence of error, noise, and uncertainty, and use all the sources of information, including context, task, and environment. This usually boils down, in actual practical implementation, that not only must you have some kind of a sensing device, but you must also have a processor right behind it. It is currently possible that both of them can be one and the same thing, if you use CCD or some other technology, so that you can actually do the processing of the sensor data right away. In all cases, it involves a processor and a memory and other things that we have come to expect of a general purpose computer, including programmability and fail softness, which are not there in many of the computers today.

The next topic I would like to talk about is intelligent machine tools. As I said, often in a capital intensive factory, the cost of the machine tools far exceeds the cost of the human labor. The question is, how can you improve the productivity of the machine tools themselves. If you went into any factory today, you would find there are large machining centers which are running at 1 percent of their rated throughput because one is not able to program them due to various constraints such as vibration or other types of things. And if you can build intelligent response sensors which will make it possible to detect breakage in the tools or wear of the tools, and by this I mean forced adaptive machining of some sort so that as the tool wears out you don't try to machine at the same rate or you do not try to remove metal at the same rate, or dimension adaptive systems in which, as a machine tool wears out you can automatically reprogram the machine so that you can correct for the tool wear. Number three, vibration adaptive machining,

Almost every system you are machining has natural vibrating frequencies. If you can determine what they are, you can machine at a higher speed rather than a lower speed, so as to by-pass the vibration sensitive area of the machine. Almost all of these and a number of other techniques must be added to the machine tools and flexible machining centers. The kinds of systems we are looking at are what we call sensor intensive flexible machining centers, where you not only have a machining center which can produce different types of parts and can be automatically reprogrammed to produce parts on demand, but also systems in which you can automatically detect tool breakage, tool wear, or vibration intensity to automatically correct for those things.

The other area in the factory of the future is essentially what you might call blue collar robotics and the kinds of functions most of these people perform are material handling, assembly, inspection, packaging, and so on. A major area there is inspection. Inspection often does not require a robot per se, but nevertheless it requires intelligent sensing to detect the defects. More than 30 percent of blue collar workers in a factory are involved in inspection and quality control tasks. The issue of how to improve their productivity, what kind of systems and intelligence assistance you can provide to help them do their job better, becomes of extreme importance. Many of these will not involve a physical robot.

One of the things you will go away with, I hope, is the concept not of a robot as something that is physically doing something, but in general a sensing, thinking, acting kind of an engine which may or may not have one or more of these parts. We need to somehow do the job, and the job is improving productivity of various levels of activity in the factory.

I won't say much about the materials handling or assembly, except to say that currently it is not at all clear how to do assembly tasks, and it is a research topic. Most tasks that are done today by robots, whether it is in Japan or here, are in material handling. For example, the Fuji ---- robot is built in a robot factory where robots are supposed to build this robot, except that the assembly of the robot is done by people. That's because the technology for assembly, where two or more arms have to cooperatively do complex tasks, for example, is not well understood. And there are a number of research projects underway, both for electronic precision assembly and mechanical assembly in which you can do these types of things. It will take five to ten years before we can even begin to have systems that can do complex assembly. I've seen a set of numbers from General Motors. Currently, much of their robotic applications are in material handling and welding and painting. By 1990, they estimate that 5,000 robots out of 14,000 they are predicting will be in assembly tasks. Assembly will become the number one application. But the technology for that is not yet here.

Let us talk about white collar robotics for a minute. The key issue here concerns both professionals and management. Let's talk about professionals. One of the ideas that is very exciting and interesting for us is the concept of functional design. One of the problems we face, especially in defense industry, is when you built a submarine in 1950, there was not even the concept of a transistor; perhaps if you built it in 1958 or 1959, there were germanium transistors around. If you build a system with that and it has a life cycle of 50 years, the Department of Defense requires you to stockpile those transistors for 50 years. And there they are - most of the time they are never used and they are completely wasted inventory. Furthermore, after 20 years, people come who were never educated in germanium transistor technology - how to fix this electronic instrument if something goes wrong with it. So the issue is not only is it important for us to have electronic or mechanical design which performs a particular function, but at the time of the design, to design it in such a way that it is technology-independent. What you want is essentially a functionally equivalent component. The acceptance within the Department of Defense of functionally equivalent components, whether they are mechanical components -- if today I have composite materials which are stronger and lighter and will perform all the functions that I used to use stainless steel for, why not use the composite materials? Why be completely bound conceptually to the old technology and stockpile the old materials? You can come up with systems in which functionally equivalent designs are acceptable, and this is very easy to conceive of with an electronic design where you can have essentially the same card cage and everything else. It may plug into the same thing, except most of the thing may be air. There may be only one chip and that may even be programmed because much of the hard automation of yesterday can be done in a programmable way today by a single microprocessor. There is absolutely no reason not to be able to accept such a change. But I believe that's the only way in the future you can produce subassemblies or components on demands - a parts-on-demand idea. The idea should not be that you produce the same old thing, namely germanium transistor electronic circuits, but an equivalent circuit that performs the same function, that has the same interface characterics. What is inside it should not matter to you, as long as it can be demonstrated that it will perform the same function, as well and more reliably. So the most important concept I think we should be thinking of, if not for this decade, at least the next decade, is the concept of functional design which is independent of specific technology.

Number two - automatic programming from geometry. Currently, rooms full of people in factories sit down and begin designing the programs for producing different parts, and they go and debug them and do various things. If you are talking about productivity, there is no reason to talk about improving productivity

I don't have much time, but let me take one minute to talk about systems for hazardous environments. I think we need to begin to talk about ocean systems, autonomous underwater systems, which will be very important, not only for defense application, but for mining of the ocean, inspection and repair of offshore structures, salvage and rescue types of operations. In the area of defense, there are direct immediate research problems, such as target identification and landmark detection and obstacle avoidance path planning and navigation in the ocean. Can a robot, whatever it might look like, go to a particular place in the ocean, uniquely to within an inch, and perform a particular task and come back? Currently, we don't have such an autonomous technology, although it may be possible to do that. Exactly what kinds of technologies that are useful to do that is an interesting thing to speculate.

The same thing is true for space. We have the problems of space garbage getting larger and larger, so systems that can do space garbage collection, space material handling, space construction, and space rescue - what you might call a gopher in space, without having to have a person there to do these things - this is interesting to speculate. I believe it can be done. In nuclear systems, whether they are man-made or accidental nuclear explosions, we don't have all the technology we could conceivably have to rescue ourselves from such disasters. Systems that can monitor thousands of sensors continuously and automatically detect various crises are systems in which inspection and repair can be done in highly radioactive environments.

I think the concepts are around, but nobody is seriously working on them. Almost every one of these things is probably of the complexity of putting the space shuttle into space, and until we determine that we are going to do these things, they won't happen -- and if somebody else does them, then we'll be in big trouble.

Thank you.

Question

How many people are displaced in the auto factories in Japan and what has happened to these people?

Dr. Reddy

I don't have the exact number, but let me give you the general strategy, as I understand it. In the 60's, when there was a rapid growth of industrial productivity in both Europe and Japan, Germany followed a very different course. When they needed to increase production, they imported people from Yugoslavia and

and Turkey, from Italy and other places. Now they have a lot of immigrant labor within Germany and they are having problems with that. In Japan, for whatever cultural or other reasons, they have decided that they are going to be limited in population and if they are going to improve productivity and improve the GNP, they have to be able to produce more with the same labor. So even though at the time they were doing it, it was not cost effective, they decided to go for as much automation as they possibly could. This is a very telling factor. Secondly, we hear about this lifetime employment issue in all the factories. It is apparently not quite true. From what I understand, the big corporations do, in fact, have lifetime employment. But much of the tasks that they do are contracted out to little outfits, which come into being for a month or a year and then they die. Apparently, there is growing discontent within the country because these people don't have job security. So the general statement is, for the kind of production they want, there are not enough people. So the likelihood of the same degree of unemployment there as there is here or in Germany is not going to be as critical for them.

(Question is unintelligible)

Mr. Yaroshuk

The question is from a gentleman from Detroit and he is very concerned about the visibility of the high unemployment there and makes a few excellent points about how many robots buy houses and other consumable goods, so robots are not part of the cycle.

There's no question we should all be concerned about human factors and retraining. As a general rule, we put robotics in - and we've put in over 50 to date, and we plan another 50 or so for this year. Once we move a robot in, we certainly do not move a man out. At this stage of the game, we are retraining people for other activities and we're picking out the jobs that are hot, hazardous, monotonous - they certainly are the kinds of jobs that people are bumping out of - they just don't like them. As a general statement, we in the corporation are looking at the full aspect. As far as discussions, top management is looking at this head on. I want to make this comment. The same question comes up over and over again. There rightly is concern. Robots do not buy automobiles. They just do the work. We need something in this country to raise our standard of living. Our standard is going down. We all realize that. We hope to turn the tide with this kind of machinery. We expect that we are going to raise our standard of living through things like machines that can get more output per hour. I think the lay-offs and whatever, there's a social problem in this, of course. But the robots and flexible manufactured systems, more intelligent inspection systems, they can give us more output.

of those programmers. So the issue, then, is if I gave you a complex part that had to be produced as I designed it, could a program that would not only control the machine centers program for controlling the robots, program for controlling the inspection stations - could they all be produced automatically? It turns out that compared to other types of automatic programming tasks we are looking at, these tend to be fairly straightforward and can be done. I don't know how many other groups are doing it. I know at least one or two commercial enterprises do some of these things, but not in the fully generalized way I am talking about. But I think overall, such a technology exists today, but it must be adapted.

When we talk about the Japanese, it is not that they have much better research or much better technology, but they seem to make much better utilization of their existing research and the research that they get from the USA. This is where I think we need to somehow find ways of improving our productivity of technology transfer.

The last area is intelligent logistics support, which is essentially asking the question of how you can, in fact, improve the productivity of factory management, foremen and above. What do these people do? What does it mean to improve the productivity of factory workers? Essentially, most of them have to deal with ill-structured situations, situations for which things are not written down in books. A new crisis comes up; a person is sick; a machine goes down; raw material doesn't arrive - a number of other things. At some conceptual sense, it is no different than logistics support in defense, but it is narrowly defined in a factory, a small person operation. But in order to do this, you must have a sensor intensive factory with this information cable I was telling you about, where almost the entire status of all the resources are available to the system. By resources, I don't mean just raw materials. I mean people; I mean capital equipment; I mean tools; I mean orders; everything. And if you can, in fact, track everything that is going on untouched by human hands, if you will, in a factory, then you can begin to talk about fully automated factories. And this requires systems that can sense continuously-sent status and perform scheduling in the presence of failure or absence of personnel, and do planning to determine where the bottlenecks are, and perhaps even order automatically what additional equipment is needed to remove the bottlenecks. This type of function can, in fact, be done. They don't all have to be done completely autonomously, but if you can produce tools in which many of these alternatives can be examined very rapidly, that can be a significant aid to improving productivity of management in the factory, namely, the status, scheduling, analysis, and planning types of activities that go on in a factory.

This will, in general, raise our standard of living. They will certainly do that.

Dr. Reddy

Let me add to that. At Carnegie-Mellon University, we have a major program in the Robotics Institute on social impact of robotics as a whole, not only economic but also legal and social and historical. One of the things we are trying to do is, in fact, act as a catalyst to bring industry, unions, and government together to come up with strategies and techniques which will help to solve this very important problem. I'm not sure whether we can provide specific solutions, because we are neither the hirers nor workers; however, I think one of the important things we have to be aware of is if Detroit is in the trouble it is today, it is not because they introduced automation. It is because they didn't. We can continue on like this for the next 20 years, but we won't have much of an industry to speak of in this country. You can be sure of that.

So there are two issues. First, we have to deal with the immediate problem of what to do with displaced workers. Second, we have to deal with the issue that in 20 years from now, there may not be many industrial jobs at all. That's like in agriculture where 60 percent of the labor force used to be in agriculture 50 years ago, now there are only 3 percent and they are producing more food than we need for the country. That's going to be true with manufacturing jobs 20 years from now, if we are going to survive as a manufacturing nation. Then the question, of course, for long-term social studies points of view, is since the jobs are not going to be there for the second- and third-generation people that come in manufacturing, what are they going to be doing? People suggest a number of solutions, such as space or service industries or doing a number of other things, but I don't know what the answer is going to be. But it is clear, one way or the other, there are not going to be manufacturing jobs. You can be absolutely sure of that. So what do we do?

Question

Do you feel that if we can deal with the issues of human factors, such as Quality Circles, we may be better off than with automation?

Dr. Reddy

That is, in fact, a very important contributing factor. There is no doubt about it - the issue of life-time employment, the issue of the lowest-level worker being able to speak his mind to the foreman is important.

(The remainder of the Q&A session was not recorded.)

Mr. John H. Dutton

(The introduction and beginning of Mr. Dutton's presentation were not recorded)

As an overall mode of operation, we set objectives up front - three dimensional, more graphics, we wanted to reduce the base cost 42 percent, more user human interface type of thing. As a means of showing how we organized that project and some of the key issues in making that happen, I've gone through a little project history here with mid-1979 implementation as the bottom line. Of course, management - both user management, functional management, project management, the computer science disciplines, and so on - were all included in the overall study project itself. You can see a heavy emphasis on management and technical review boards to make sure all the contracts that were appropriate were signed up front and agreed on. Human engineering was a significant part of this. The terminal interface with the people themselves was completely designed as a separate operation for the most effective man/machine interface.

This is the basic comparison of the previous central system and the distributed system, where we basically kept all the basic geometry, number crunching up on the central system, and moved a lot of the human scaling, viewing, quick response type of activities out into the basic mini-computer itself or into the basic microprocessor driving the basic graphics itself.

Here is a typical design station. We implement several locations for maximal location to the work areas themselves and in some cases, they are concentrated to get higher utilization. Basically, the process starts in the engineering environment and way up in the configuration development. We use a typical synthesis program that have cost implications to synthesize the mini-configurations down in the preliminary design. We start using the basic computerated design graphics system for placement of aerocontrol surfaces, engines, stores, etc.

Another basic application that is very effective is the 3-D Kinematics. This is the F-18 landing gear type of problem, looking at the complex interface between the inlet, center stores, wing stores, and folding that landing gear back into that wing structure. The number of iterations that you can do in a period of time to optimize the design itself, with all the interaction factors, is one of the major advantages.

This is an F-18 fuel cell, where you are trying to get the maximum fuel in the available volume, going around various structural entities, and maybe lines for fuel transmission. That's a completely surfaced part. Now that we have the completely surfaced part, in about two seconds we can get all the basic volumetric properties and surface properties -- volumetrics to calculate fuel and location of that fuel as far as CG and various flight attitude, etc., -- surface properties that play

directly into the wake, accounting programs, and so on. Similarly, the analytical disciplines address that same data base. Here you see a gentleman sitting at the CRT defining the mathematical representation of the structural model, using that same geometry data base. As a basic output, he gets all the internal load distributions associated with the load conditions, etc. And we can produce a complete engineering drawing. A lot of the data is digitally passed for reference purposes, or customer requirements, outside vendors or suppliers that may not have the capability to tie directly into D&C.

I'm going to go through several generic applications - in this case, NC machines, to see how we should work that basic process.

Basically, there is the machine part done by the designer, passed out to the manufacturing planner. He takes that basic digital information and constructs how he wants to produce that part, in terms of machine feeds, speeds, etc., and then gets a graphical simulation of the machine tool moving around that part for cutter path verification itself.

Here's a typical five-axis gantry multi-spindle profiler. In this case, you're seeing machine parts for the F-15. You'll see on the bed, while this part is cutting - we're getting three parts cut here - there is another bank of three parts set up and another bank of three parts set up to pass on. Basically, all three- and five-axis machines operate seven days a week, three shifts a day.

Similarly, the next step down the stream is the quality assurance inspection itself. The quality assurance individual sits down at the same CRT, addresses the basic design definition and detects where he wants that part inspected on a D&C inspection machine. From that point, out at the inspection machine, through D&C, it's driven and it detects - the probe coming down there gives him a read-out verifying the actual hard dimension back to the design data base itself. This is generally done for check-out of the machine parts program itself, and then that's put in a release only file to drive such operations.

Similarly, a caddy in the sheet metal design area, the loft interface I showed you for geometric definition on the surfaces can come in at that same CRT, pick up the line definition itself, design the sheet metal part, and then, hitting the basic function that allows you to flat pattern, can produce the flat pattern of the part itself with form block lines, etc., with all the basic notations that are additionally needed in that area.

Of course, to enhance the utilization of material and to allow D&C router operations, we do a nesting type of operation.

This color is not in full production. We are using it in the manufacturing and planning area right now. We intend to go that way, using color graphics, but you can see the visibility - blue in the part, white in the basic material that is being used, and pink for the fastener holes that are used to hold it down or subsequent tooling holes for assembly. They then go through the trunk router, where we can stack many sheets at the same basic time. There you can see the basic stacking operation. This is where the classification coding group technology that we're actively working on will be of high value, because you are talking about the same gauge, temper, etc., similar characteristics of the parts to do it. When you're talking small batch manufacturing, that has to be handled very carefully.

Now I would like to go into the composites area a little bit. On the F-15, we had 2 percent composites; on the F-18, we're about 10 percent composites. There, we're talking about maximum utilization of material and volume, minimum gauge for strength. You get into many, many plies - hundreds of plies - each of these have to be individually flat-patterned from a three-dimensional design of the part itself. Here's the basic layout that the man has done on the tube, showing the fiber orientation itself for each of those individual plies as they lay up. The nesting is more critical because of the cost of the material, and you see on this particular nest, an 80 percent yield.

From there it goes to the D&C laser cutter, also tied into the same D&C, to actually cut from the basic broad goods, which are fed back through to the cutter. Manual operation here is then collation of the final parts as they come out and stacking to go to the lay-out room.

On the AB-8 -------, we're talking 25 percent composites. When you get into those areas, you're talking about major areas of productivity improvement in terms of overall inspection of the parts themselves. In this case, this is an ultrasonic test facility, automated, with read-outs here and additional read-outs from memory for specific looking. We also do a similar type of thing and have in development that and the x-ray continuous scanning operation.

Tubing - in the past, a lot of you will remember tube and cable mark-ups, and the difficulties in fitting parts on assembly when you have very complex routings of tubes themselves. Remember the old master racks - hand-formed, built up, that becomes your master tool. There is also verification by quality assurance. All those tubes now have been replaced by using a technique where the man sits at the tube -- he's a systems installation engineer. On the F-18, we zoned that out by

sections where the systems installation engineer did all electrical fluid, etc., in his zone. Here you can see him routing in amongst the structure to actually define the overall routing of that operation.

This is probably the most overall integrated and the way we are looking in all the other generic areas that I showed previously. We are now at that same technical design type of operation where a man can call up a module and that also now allows him to place in a lot of the other information associated with test pressures, materials, specs, etc., to produce a fully integrated data base, a product definition with all geometry and non-geometry data. That goes through a microprocessor controlled machine which will produce the same part as the automatic spring-back for very good quality. The unit also goes through an automated inspection machine.

It doesn't have to be fancy. This is a sheet that follows out in the shop, giving basic information automatically from the machine - end item, down, up, basic labeling, etc. And, of course, in this case, automatically produced is the completed MIL-SPEC A-sized drawing to be sent to the customer as part of the contract data requirements.

Here's our utilization history on various projects. As you may not have noticed, where the major surface definition then allows you to go out into the parts programming to produce the parts. Capability generated in this timeframe allowed us to do major increase in the use of that to drive the NC machines out in this timeframe.

That's the high side mix. On the low side, we also use a decentralized, which as I said before still ties in communications wise with the main frame systems for other interactions with other applications. This is a basic turnkey system. It's used for schematics, it's used for control system schematics, feeds analytical programs, etc. You can see some of the interesting configurations that we both develop on there and the configurations of the user.

Now I would like to go into a little of the more near-term three-year kind of environment and in this particular case, looking at an application that I would say is starting to get into some of the higher intelligence in the machine tools themselves, where we require very expensive and extensive set-up time and a lot of hard tooling, and require significant precision. In this particular case, it is the F-18 inner auto wing - 7,400 fasteners themselves, and we're talking about attaching composites to aluminum and titanium substructure. As you can see, there are significant percentages - 59 percent of the

drill-related hours expanded on handling operations themselves, and the number of drill motor set-ups, etc., in the very complex blankets with adjustable features to account for tolerances and so forth. That shows you some of the substructure and all the fastener holes that have to be drilled and have to fit the surface skin plus the groove seal lines that seal the basic fuel itself within the wing, and the precision with which you have to hit those.

Our proposed concept that we're in the process of implementing and are about to release for development is a concept where we're using basically five access drill units and you can see four of these - two on each side - and basically, initially there is a video scanner that scans the substructure off some key reference dimensions and looks at edge distances on the substructure, looks at the groove lines. The key features where the very careful tolerances have to be maintained themselves. After that scan operation is completed, then it goes into a test mode on the microprocessor, then the skins themselves are pulled in place and for the larger assembly, all four of these units can be working at the same time. The basic savings that we're seeing and are anticipating in that area is about $3 million a year savings, up to 90 percent reduction in set-up time, and almost 40 percent reduction in the drilling time itself. One of the big advantages, again, is in the quality where a lot of the hand tooling required subsequent reaming operations, one pass drilling with this type of arrangement eliminates a lot of that.

Another example of getting into automated positioners - this is the MANTECH ICAM Task B program that we were involved in. This shows the basic prototype demonstation manufacturing cell. Over here is a conveyor that dumps the basic part set up with several stiffeners adhesively bonded to a basic flat sheet. It comes over onto a set of fingers. Cameras take a picture of it, give basic position, the positioner comes in and picks up that part, moves it over to a higher resolution set-up camera that gives more accuracy to the position. It is then brought over to the basic device that then drills the holes, within about 30/1000s or better tolerance and puts in the rivets all in one operation, then the robot comes over and drops it in a bin.

We're running short of time and I won't go into all of it, but this is basically what was developed as part of that basic program. We have gone through the demonstration in the laboratory environment. All these basic technologies were part of that. We are now in the process of demonstrating it in a production environment itself.

This is another application of positioners. We have now set up a cell, which incidentally also includes the 88B that will do the windshield, canopy, and ---------, a complete manufacturing cell. The alternatives we are currently looking at is whether the robot ought to move on air floats for the basic fixtures of the parts themselves, or whether the basic fixtures should move to the robot. We are looking at those alternatives. But we do have in production, has been in production for about seven months, is the windscreen on the F-15. This is the previous way - light drill motor, the man has a mask over his face, the coolants, etc., are irritants to him, and positional accuracy with the smaller units.

We have incorporated the same Cincinnati milicron T-3 that you saw in that previous demonstration cell into this environment and have designed to effectively allow us to place up to four drill motors to do that complete operation on that device. Here you see the four operating. What has happened in this, we have produced about 75 windscreens this way, which is about 8,600 holes drilled, and 3.5 hours is what it basically took to do this manually. Now it is taking about 1.9 hours, and because of the heavier drill motors that you see here and the better control on feeds, etc., we expect to get that below 1 hour because we do not have to do the subsequent ream operation itself. The big advantage is quality, again, as well as that savings. The quality itself used to be 10 to 15 percent rejection on those holes. It's now less than one-half a percent.

One of the other areas of new machine technology we are in the process of implementing is composite materials cutting and collating machine. A dual machine - broad goods starting down here, going through a laser device here, pre-inspected in this region, finished part here, picked up here with vacuum pickups, which moves the part down and collates it to within about 15/1000s accuracy itself in terms of the over-all lay-up. Here you see a planned view of the system showing more detail of what I just described. The details on the vacuum pick-up, by the way, the expected capability of the machine is to be able to move about two plies per minute on each side. And, as I said, the positional accuracy of laying it up to within about 15/1000s.

There is still some manual operation that we're looking at, but basically moving from that table through the basic racks themselves, from the racks to a forming station where a little bit of a pan free-forming is done, and then it's vacuum-formed and taken out to be put into the autoclave.

That's our planned machine loading - 53 assemblies with some assembly parts on the F-18. The status is the purchase order has been placed, the basic design of the machine is about

80 percent complete. We expect to do a production prototype demonstration in the fall of 1982 with implementation in early 1983 in a production environment.

This is a little farther out blue sky, but it gets in the things Bill was talking about in forward cell manufacturing itself. Starting with the basic tools here, and you see the little automated carriers for material handling, tool handling, or various things of that sort. Down in tool preparation, you see the composite, the collator cutters down in this area, some of the forming stations in here, a five-axis core carver that's been purchased, and then, of course, moving over into preparation storage for the autoclave itself. Also looking at nesting within the autoclave. That is a volumetric nesting as a major resource.

Some of the way out features - and some not to way out. It's difficult to talk about all that at one session, but the solid modelers, that's key to the thing Bill was talking about in terms of automatically doing parts programming and even generic planning that attaches it with itself. Architecture modularity - you can be much more creative in modularity in terms of the software application, flexibility in using the capital investment, so we can migrate to the various environments. So you'll see it all there, down into integrated technology which a lot of people call CADCAM positioners, composite resource management control, and so on. I'd like to just mention that briefly. We are in the process of implementing a production system that does the overall composite resource management, scheduling, planning, looking at all the resources in the composite facility itself - the tools, machines, and so on. If that works effectively, we will take that as a model and implement it in the machine shop, in the sheet metal shop, and so on.

I'd like to talk a little bit on that human-machine interface because while I think a lot of things can be automated, we've got to keep the man in the loop to a certain extent and increase his application of the technology - his knowledge - for using the tool more effectively.. One of the areas, as you can see - this is a completely surface part. The ambiguity is terrible. The next step beyond that is to identify hidden lines. Now you get into the color raster and now you can really see that part clearly, as well as being able to choose certain colors for certain characteristics of the part - different colors for grooves, etc. We are working with techniques to use that basic technology with the solid modelers, etc., to automatically create not only the parts program itself but also the planning information that goes with it.

I'd like to conclude with a few charts that define an overall activity that has gone on for about a year and which McDonnell Douglas concluded last August and we had basically implemented the majority of this as some indication of what we have seen to be a way of healthy re-visit and re-look at how we can move the technology faster in this whole use of computer technology.

You'll see a lot of the key ingredients of QC - executive, top level involvement, right down to the end user and the user has tremendous ideas. He knows his job best and how that all feeds together. Looked at all the existing policies, organizational structure, and looked at the advanced technology trends themselves. Of course, the result is re-structure appropriately and to improve the effectiveness of the computer based systems - and integration is the key word.

We call this information resource management. It's broader than CADCAM - yet CADCAM is a portion of this activity. We looked at all the basic resources themselves and looked at the overall planning and control - the objectives, the policy, and so forth. We set the policy, the who and the what, and then did the how last. But the how has to recognize the existing organizational structure.

Some of the major driving factors are the price, performance, the computer industry, the convergence and the communication technologies, data base. A lot of people are coming out of school that really understand this environment and are very knowledgeable and top management is getting very much involved in this environment. There's a growing recognition of the distribution - out to the end user function for control, maintain the technical compatibility to handle that distribution.

Some of the key policy considerations that we implemented were the integrated formal planning and review process; this has to be compatible with business objectives and the structure of the organization. Architecture; maintain technical compatibility only where it's important to maintain technical compatibility for integration and so forth, and then let the rest of the people innovate. That's also true with the standards and guidelines. Guidelines, I think, in the existing technology, is the area for greatest improvement and that is management of the technology that we now have - better management of the technology and the application of that technology to the existing processes.

Some of the additional things - user management education - that's everybody's job. Long range versus short range benefits - we definitely have to impact the short range operational environment while building a generic-based technology for the

future. That's the key issue - to look at both. Integrated planning for the benefit of the whole. Cost benefits, etc., have to be company-wide related to bottom line, whether it be performance, cost savings, whatever productivity factor you choose to use.

There are a lot of specialists in this particular area. More and more digital products are on the market; therefore, we have to become better at how we control and protect that product - disaster planning, etc. And the flexibilities within the facilities - microwave, infrared between buildings, fiber optics and better networks associated with it ties into the office automation environment. And we must do a better job of getting the cost and productivity savings into the operational environment as rapidly as possible. If you get the technology in quick you also have to effect it fiscally.

This shows the model organizations that we've implemented at each one of our major components within the corporation and mirror imaged at the corporate office level. We didn't even give them specific titles. We let the components choose what they wanted to be called. The key ingredient is for the integration to occur across all the functional areas. To make sure that top level involvement occurs, a steering group, chaired by the Executive Vice President and having as members all the vice presidents and division heads, and - very key - component program manager, because he is the end user of that technology, not only functional involvement but program involvement, as well. Because of the involvement at McDonnell Douglas with automation companies, they have to be involved. They provide a lot of the services and talents to develop the systems that they use, and major ad hoc projects. That's critical. The projects are ad hoc; they're put in when they're multi-division, cut-across division; the best man, depending on the most emphasis, comes in there to head up that project. The basic people come out of all those organizations, they get put in there, they do the job, they bring the expertise, the job gets completed, and the people go back - they stay close to the end user environment itself. Division-unique things are kept there, but when they're multi-division, they're done in this environment. That's the program management aspect of it.

Summarizing what I consider to be the key issues in CADCAM system management are planning, the management basis for effective control. Management has to understand and has to have the guidelines for effective application and, where very specifically required, control procedures to make sure the process ties together and that what is supposed to happen does happen. And keeping the users and user management involved is essential, which feeds back into the end user requirements and then planning is an ongoing process.

Overall, requirements for the 80s as we see them in the use of computer and various technology, cost benefits, advances in technology, the clear statement of objectives and policies, organizational focus, major implementation of communication. I heard a statement by Dr. Currie that related to communication of digital product out to the suppliers - I think the activity and approach we're doing, corporate-wide, is looking at the ANCY-1426 Standard for communication product definition. It's an excellent mechanism to communicate from one type of CADCAM system to another, both geometry and non-geometry.

Robert E. Hilchey

Thank you, and good morning, everyone.

This is a particularly significant point in time to discuss White Collar Productivity. Because this year - 1981 - we are observing a significant anniversary. A 25th anniversary, and note that I said we are observing an anniversary, not celebrating one. Because, frankly, it's an anniversary I would just as soon do without. For 25 years ago, 1956, was the first time that the number of white collar workers in the United States was equal to the number of blue collar production workers. And, of course, it didn't stop there. The population of the white collar work group now represents some 70 percent of our work force. And there is no end in sight for this white collar population explosion. That is, there is no end in sight unless we, as business and government managers, develop and implement some very effective birth control methods.

Whenever the subject of white collar productivity comes up, I always think of the aggressive young executive who was appointed president of an old-line company. It became apparent to him his first day on the job that the work force was still doing things the same way they had since the beginning of time. So he went to work developing a new management system with computers and all that. After months of seven-day-a-week effort, the system was installed and tested, and the worn out executive took off on a month-long vacation in Europe.

On his return, his first question was, of course, "How is the system operating?" "Just great," they said. "And how is business?" he asked. "Well," they said, "to keep the system operating, we had to give that up.

We can all laugh at that story, and we do. But I can also understand that something almost like it could actually take place. Let me go back a few years to set the scene.

The June 30, 1975, issue of Business Week magazine featured a major article on something called "The Office of the Future." It was an enthusiastic report on the rapid advances being made in electronic systems and equipment which promised to provide tremendous improvements in productivity of offices and white collar employees generally. And the article also predicted that these new technological gains would be broadly accepted and implemented across the land by 1980.

1980 is now history, and that promised rose garden of vastly improved white collar productivity-through-technology is far from blooming. As a matter of fact, I'm afraid the garden is heavily infested with weeds - weeds in the form of a very basic problem which we must confront - and solve - if we are to achieve a level of true competition in the world market.

Perhaps the problem is best summed up by the recent observations of Andrew Grove, the Chief Operating Officer of Intel, who said, "We don't really know what clerks, financial people, or managers do - how well they do it against some standard or in comparison with their peers." And Mr. Grove rightfully concludes with the question, "If we can't measure it, how can we hope to make it more productive."

Let us look further into that problem as it faces us today. In essence, it is tripartite in nature: it involves considering the true administrative needs and requirements of business; it involves people and people-management; and it involves technology.

The white collar work force has grown by leaps and bounds since the turn of the century. To use a medical analogy, if we consider the unchecked growth of the white collar work force as a cancer, we must take immediate remedial action or it will soon terminate the patient -American business - and remove it from the arena of world trade. It is just that serious a disease.

Let us examine the American business and industry picture as it appears now, in terms of goods and services. In 1900, the product-oriented businesses provided about 75 percent of all civilian employment, with services accounting for the remaining 25 percent. Today, those numbers have been almost reversed, with services approaching 780 percent and continuing to rise. And the same study predicted that, if this same trend continues, the $600 billion of 1979 will steadily increase to the level of $1.5 trillion by 1989. Let me repeat that -I said trillion, which is a number with 12 zeros at the end, not just the usual 9 zeros of billion, which we used to think was pretty large.

Reports like this on white collar employment have begun to get lots of attention. One of them in U. S. News and World Report magazine last month pointed out that organized labor has got the message and is now significantly intensifying its efforts to unionize office employees. With membership in such unions as the auto workers and steel workers continuing to shrink, the emphasis is shifting toward bringing in new members from the 17 million clerical employees in the United States. And since this number is estimated by the Department of Labor to grow to about 22 million by 1989, union officials see this group as offering "a wide open field."

Let's put the problem of white collar productivity in perspective. Perhaps we can agree that we're dealing essentially with the development, storage, analysis, and communication of information needed for effective business operations. It is a matter of utilizing knowledge for human purposes. I'm told that man's recorded knowledge throughout history up until the year 1800 was doubled between 1800 and 1900. It doubled again by 1936 and again by 1950. It is now doubling every six years,

and we see no end to this trend. So it is not a matter of not having the information. We do. The fact is that we are regularly inundated in a sea of information. It's sort of like the feeling John Jacob Astor seems to have had after the Titanic struck an iceberg. He is reported to have said, "I know I rang for ice, but this is ridiculous."

We seem to be able to amass an iceberg amount of data, but it is much harder to get an ice bucket full of useful information.

And what's the undesired fall-out of this information explosion? It's the requirement for a whole tier of jobs. And we fail to examine in the first place whether all of this information, which generates all of those jobs, is necessary.

Just what is the vital information that we need to run our businesses and do our jobs efficiently? We tend to let the wrong person answer that question. It's like asking an insurance salesman if he thinks we should increase the size of our policy. We tend to let the information system specialist tell us what kind of reports we need. Or we compound the problem by asking him for newly thought up specific reports which we just think we need. As a result, we get information - and it just keeps coming - like that unending assembly line of pies in an Abbott and Costello comedy. Those data pies just never stop. If you don't consciously call someone on the phone, you're going to get those reports for the rest of your life - and they'll no doubt keep coming even after you're long gone.

Somebody is getting job security out of all of this - or job promotion - or job title. It's the computer people, those who do the software programs for us. I can't think of an industry today that isn't plagued, or at least they think they are plagued - with a shortage of computer software people - more people - to give us more information - for us NOT to use more often. On a real time basis, I don't know what to do with half of the stuff I receive.

Our whole information flow is simply not pre-planned. It grows just Topsy. And we keep building and building on top of it. Maybe if we're lucky, some day it will collapse of its own weight and we'll have to start over again - and this time do it right.

As a nation, we create 30 billion original documents every year. And despite our gripes about the post office, we use it for more than 630 billion pages of mail annually.

We love copying machines. Last year alone, our busy copiers produced 100 billion pages of information. Because of this flood of paper, we read only half of our mail - if that much. And we never again use 85 percent of the paper we put in our files. As a result, we maintain 4 filing cabinets per employee, a number which will double to 8 in the next 5 years.

I was reminded of this growing problem of paper files recently in my role of responsibility for our industrial engineering and plant layout functions. The initial plan was to move a group of specialists into an area on the fourth floor in one of our buildings. But in developing detailed plans, it became obvious that even the unusually great strength designed into this building would not support the large number of very heavy paper-filled filing cases used by these people. We had to revise the plan and make room on the ground floor.

It was only a short time later that I noticed a huge truckload of paper at one of our receiving docks. I laughingly remarked to the trucker than an order of paper that size should take care of us for a while. "Oh, I don't know," he said. "We deliver that much every two or three weeks." I subsequently learned each delivery consisted of 20 pallets - each loaded with 40 cases of paper - and that each case contained 5,000 sheets. Total -- 4 million.

That got my attention, so I did some checking. At our Anaheim facilities alone, we use 100 million sheets of paper per year in origination and reproduction of letters, reports, and other business documents. We use another 25 million larger sheets for print-outs from our computer systems annually. We have nearly 2,500 different forms - a number of them multi-copy - which account for another million pieces of paper per year. We even have a form to initiate and another form to cancel the form.

This total of about 126 million pieces of paper a year works out at about 20,000 pieces of paper per employee per year. Or, looked at another way, we use more than 500,000 pieces of paper on the average working day. And, referring back to those file cases, we buy and use more than 300,000 manila file folders each year to accommodate our continually increasing use of paper.

These numbers are disturbing to me for several reasons. First, they provide clear evidence of the shift in emphasis from production of goods to production of paperwork - and more and more requirements for white collar activities. Second, the trend has been established and there seems to be no sign of a reversal. Third, this huge amount of paper is still required despite our active and continuing efforts in cost reduction programs aimed at improving productivity in white collar areas.

The fact is that we have saved many, many millions of dollars over the years through such programs, and, though I guess I should never put it this way, we have paperwork in the files to prove it. But another fact is that despite the success of our efforts in the white collar area, we are still struggling just to keep up with current demands on our information processes.

Current demands on our information processes -- just what are they?

Many of them, of course, are required by business for its own operations, such as employee communications, management reports, sales orders, engineering documentation, and so on. But this normal stream of paperwork has been in recent years turned into a flood by the thousands of pages of new government regulations - all of which seem to require frequent and complex reports.

As you may know, the annual cost to American business for this additional paperwork has been estimated at $100 billion or more. Many, or perhaps even most of these unavoidable and very heavy requirements have had to be met manually by managers, professionals, and clerical personnel.

There is another reason why we have our current serious problem in white collar productivity, and that is because we have placed almost complete emphasis upon "factory productivity" and have ignored, relatively, "white collar productivity."

Billions of dollars have been spent by business in the past few years on facilities, equipment,, and improved production so that we can comply with environmental, safety, and a host of other government regulations. Such capital funds as remained were, for the most part, spent in updating old buildings and machinery and providing additional automation for production work.

When the trade-offs were made in regard to manufacturing goods for people - or investing more in improving white collar business systems productivity - the factory requirements generally won out. But efficiency in white collar productivity is not dependent only on money and equipment. There is, as you might expect, the involvement of people.

A major area of concern I see facing us is our ability to manage the white collar work force. I'm not convinced that our management concepts or management techniques are keeping pace with the changing society we have. The social needs and work ethics of today's work force - and especially the white collar work force - are not what they were ten or twenty years ago. I'm sure you people in the Navy can bear this out. I doubt if today's Navy personnel are being motivated or managed by the same techniques that I was motivated by 25 years ago when I was in the Marines.

We've got to go further than just understanding the text book management concepts of theory X, theory Y - and now theory Z. We've got to bite the bullet and acknowledge and accept that today's worker is different. He or she is well educated, even well-traveled, and living a middle class life outside the job.

The nature of the American worker has been, and is, changing rapidly, and the change is coming at a time when productivity is facing a crisis. If we look at some of the office work these highly educated people are doing, we see them doing mundane things. Those are the things that should be done by machines - and let people do the thinking.

The complexity and sophistication of the work done by a number of our white collar people is very low. The time and efforts of a vast majority of that white collar force are spent processing forms, doing almost primitive bean-counting operations and keeping track of charts -- until the only challenge, the only incentive to think, lies outside of the working day.

Recent investigations carried out by a team of Chicago Tribune reporters conclude that the American worker really does want to work -- but often hates the job he or she does. The worker wants to take pride in his work - but he very likely holds a narrow, boring job in which satisfaction and a sense of achievement are all but impossible.

In summary, we find a combination of forces causing our current state of diminished white collar productivity: poor analysis of our real administrative and information needs; less than sensitive people-management; and careless use of today's technology to improve white collar productivity.

Now I would like to explore a bit - explore ways to solve these problems.

Take a look for a moment at factory productivity, if you will. In our particular electronics business we now have direct labor costs down to 12 percent of total costs. Material is now running at 54 percent. What's the rest of it? White collar costs. If this keeps on, there is no question what the result will be in regard to our complementary in the world market.

We need a revolution. A white collar revolution. Let's tackle this just as we did our productivity problems in the factory. Let's get to the basics in diagnosing the ills of our white collar productivity. And here we face a grave danger - and that is because we have been so successful in analyzing and working in the area of direct production analysis and measurement. It is a danger of equating productivity in the white collar force with that of the blue collar worker. We have to be very careful to avoid tackling either the wrong or superficial problems in white collar production.

Those of us concerned with productivity have placed most of our efforts in the area of the direct production worker. This has been -and continues to be - a very vital issue. But it has locked us into a certain frame of mind when it comes to defining and analyzing productivity.

We have been accustomed to measure the rise or fall of productivity by measuring the number of hours it takes a worker to turn out a certain number of items - or things - or widgets. Out of this finite and measurable condition of "worker-and-widget" we have developed approaches to increase widget production while at the same time decreasing the number of man-hours needed to produce those widgets. All very nice and tidy.

Now, let us consider our white collar productivity. We'll find that it isn't such a neat package to measure and weigh. As a matter of fact, we'll find ourselves in a most interesting paradox. For actually, the less widgets we turn out in the white collar field, the more likely we are to be doing a better job. For example, if last year Joe Blue Collar turned out 100 widgets in a given period of time, then through the use of new equipment or different work patterns today Joe Blue Collar is turning out 200 widgets in that very same time frame, we have, in effect, a beautiful productivity achievement to boast of.

Now, let's move through those glass doors into the fuzzy floored area of the white collar force and take a look at Josephine White Collar. Last year Josephine was tabulating, recording, and assembling - either directly or through the use of electronic devices - 100 time cards in a given period. This year, because we applied those same techniques we have learned so well in blue collar production, we find that Josephine is now processing 200 time cards in that same time period. Should we celebrate because she has doubled her "output" just as we did when we devised ways for Joe Blue Collar to double his widget output? By no means. Rather, let us lament the situation. For I contend this is not an occasion to celebrate - or to be proud of - or one which we can long endure. Because we have not gone to the basics concerning Josephine White Collar. Rather than turning out double the time cards that she once did, we should have discovered ways in which she won't ever have to turn out a single time card. And while her white collar indirect labor job may disappear, Josephine is now available for more productive work.

As you can see, my concern is that due to our awareness and increasing sensitivity to the explosion of white collar jobs and the low productivity in that area, we face the danger of proceeding at flank speed - in the wrong direction - or we may steam in circles, without carefully determining our destination and plotting a correct and precise course.

We don't want to find ourselves in the dilemma of the airline pilot who discovered that all of his navigational equipment was knocked out except for his air speed indicator. Announcing this bit of disconcerting news to his passengers, the pilot came on the loud speaker and said, "Ladies and gentlemen, I have some bad news and some good news for you. Due to navigational equipment failure, we have absolutely no idea where we are or where we are going. However, the good news is that we're making excellent time."

So, too, with white collar productivity. We certainly recognize the problem. But we have to beware of making excellent time in the wrong direction. That is, we don't want to think that producing 200 time cards in 30 minutes is twice as good as 100 time cards in the same period - when in actuality, NO time cards - or zero production in the white collar area, is the most effective and best production.

Once we have properly assayed our problem, once we really can determine what our productivity should be, I view the white collar production erosion not as a disease but rather as a gold mine. A gold mine to get into with a pick and shovel, a slide rule, and a stop watch to measure the white collar worker just as we do the direct manufacturing laborer.

When I ask for a revolution in the white collar area, like a true revolutionist I want the revolution to spread far and wide. I want it to go all the way into academia and right on through to the design of our bricks and mortar - and to personnel management.

We have to insist that the faculties at the colleges and universities and other schools look to the future - turn out graduates who are employable now and into the 21st century. That alone is a "humongous" job. And there are indications that our schools are currently finding themselves almost helpless in coping with the rapid change of our business, manufacturing, and technical environment. One of the nation's leading authorities on productivity, C. Jackson Grayson, former dean of the business school at Southern Methodist University and now head of the American Productivity Center in Houston, recently warned that our schools today are "training people for a world that is fast becoming obsolete. They're coming out with useless skills. They will need new skills or they'll go jobless," he concluded.

To improve white collar productivity, we again must take a chapter out of the factory productivity book, and that is the chapter that involves the basic design of structures and work areas. We must design our work areas so that we don't have to create jobs by virtue of architectural design - jobs such as receptionists and guards and extra mail distribution personnel - extra material handlers, etc.

We can't be timid in this revolution. We must consider bold moves. Don't be afraid to throw out half of your computers - those that are contributing to that iceberg of information. Cut your mail room in half. Get rid of 90 percent of your copying machines. And get serious about people management. Let's borrow back from the Japanese that which they borrowed from us - and so richly improved upon -- Quality Circles, or as we prefer to call them at Rockwell, Employee Action Circles. They can be applied to any type of work operation, factory or white collar.

Let's take action of an heroic dimension. We have to reverse the trend. So let's eliminate those profit-eating, non-productive jobs. What am I referring to? What would I like to see disappear - and in their place see our productive work force improve? What about guards - and receptionists - and expediters who expedite things that the initial work force should be producing on time anyway - and material handlers - and librarians and assistant librarians in corporate libraries that duplicate the materials that are in the public or university libraries a quarter of a mile away - and timekeepers and follow-up clerks - and receiving inspectors - and certain program managers -plus many middle management people and a large percentage of staff.

If you want to consider a startling figure, then think about this: a recent issue of Atlantic Monthly pointed out that of all the industrialized nations, the United States is the only one who increased the number of employees in the manufacturing industries since the Arab Oil Boycott in 1973. In other words, our overseas friends have been busy multiplying and so have we. The only difference is that they've multiplied their productivity level and we've multiplied our labor force.

In comparing our work force to that of the Japanese, one productivity expert observed that we have fallen in love with the substance of structure - without understanding what it is doing to us through additional layering of echelon-upon-echelon of management. He remarked that in the United States, corporations have board chairmen, chief executive officers, presidents, vice presidents, assistant vice presidents, directors, managers, group heads, supervisors, and assistant office managers - and then if anyone is left over, we may just have a few people left to do the work.

In Japan they have far fewer layers of management, plus less white collar workers in all areas. I'm afraid that today no one is really attacking the white collar problem from the comprehensive viewpoint which is necessary to solve the problem.

I'm suggesting that we take our top IGs out of the factory for six months or a year - straighten their heads up - and turn them loose in the indirect areas.

For years we have concentrated on streamlining our factory production - now let's streamline our white collar areas. The same basic techniques we have used to engineer standards on the line to cost our products can be employed in the white collar force: value engineer the jobs; work simplify them; and yes, eliminate jobs where necessary. And this can be done -- elimination of indirect jobs --and still not cause a devastating unemployment problem. Rather, the nature of the work force would change from a predominantly non-productive, service type force to a more competitive work force.

This is not blue sky. Companies have already started doing it. One dramatic example has been demonstrated by Citibank of New York -one of the largest and most progressive of banking institutions. In the past decade it has slashed its clerical staff from 10,000 to 6,000. And note this - this happened while the bank was experiencing a tremendous increase in business volue. They've done it by a careful analysis of information and administrative needs and requirements and by the effective use of computers and other office technology.

Not only have they reduced the costs of white collar labor, but those who remained now find their jobs more challenging, more interesting, more satisfying. For example, one long-time clerk who, prior to the computer revolution, processed one routine type of assignment all day, now handles multiple chores with the aid of the computer. She makes decisions, gets more done than three clerks did previous -and is happier on the job. You can't beat that....Increased productivity, lower costs, and a happier work force in your white collar area. We must redirect our industrial engineers into that white collar work area., Get them to re-orient our information system people so that they keep attuned to what is relevant in the business world and avoid being consumed by their own Frankenstein - the computer that can product data ad infinitum for a human mind that is definitely finite.

Apply good management techniques to the problem. Analyze it -break it down - fracture it. In brief, take a good hard-nosed, value-engineering approach at indirect labor.

It can be done. We can flip-flop that profit-eroding ratio of growing indirect labor versus direct producers. And when I say eliminate jobs, I'm not referring to a reduced work force by any means. Rather, I'm urging that we increase the work force and here my emphasis is on the classical meaning of "work" which is productive effort, not industrial wheel spinning. Those overhead jobs in the white collar area, I'm convinced, can be eliminated and turned into profit-producing work positions - just as Citibank did when they cut their white collar clerical force from 10,000 to 6,000 - yet, they actually didn't reduce their total employment - just turned it around into an efficient productive work force.

I was pleased to read recently in Newsweek that some phenomena tend to help increase productivity without management action. For example, take the case of women's styles. Some ten years ago, a productivity consultant studied the effect of mini-skirts on the productivity of white collar males - I'm referring, of course, to "office productivity7." He concluded that the men lost at least a half-hour a day in ogling those mini-skirted beauties. Today, with the demise of the mini-skirt we can assume that we have gained at least most of that

half-hour of productive time back. Although, even as one concerned with white collar productivity, I think there are just some sacrifices we shouldn't have to make to gain a half-hour a day.

A researcher, incidentally, verified an axiom my father passed on to me a number of years ago regarding personnel recruitment and productivity. "Never hire a pipe smoker," he said. That same researcher now claims that while cigarette smokers lost a half-hour a day to their vice, pipe smokers waste even more time. In filling, cleaning, tamping, lighting, and relighting his pipe, the pipe smoker consumes nearly an hour a day - and costs his employer about $900 a year.

We in industry and in government must truncate the crabgrass-like growth of the white collar work force if we are ever going to re-take our place on the top rung of the international trade ladder. And we can do it. We can adapt our human capabilities and requirements to the changes brought on by a modern technology.

It is true - people do have fears. They do resist change. But we're adaptable. We can and we will meet the changes of the future, as we have met those of the past.

Just as industry today is meeting the demands of increasing and improving factory productivity, so, too, will we meet the challenge and implement the necessary changes to overcome our current weaknesses in white collar productivity.

Nearly 2,500 years ago, a Greek philosopher named Heraclitus said,, "There is nothing permanent except change." I only wish I could have thought of it first.

Thank you.

SESSION IV

PRODUCTIVITY PROCESS MANAGEMENT

Dr. Simecka

This session is on productivity process management and our Session Chairman is also our Co-Chairman for the whole conference and I am delighted to be able to introduce him. Dr. Jim Tweedale - I'm sure you all know him, but Jim is the Director of Productivity Management for the Department of the Navy.

Dr. Tweddale was selected to the position of Director of Productivity Management for the Department of the Navy in August of 1978. Prior to that time, he was Production Department Director at NARF, Cherry Point, North Carolina. Early experience includes work in engineering, quality assurance, and production management at NARF, Jacksonville. Also, he worked with the Air Force Logistics Command and Sperry Rand Corporation. He holds several patents in high temperature metallurgy. Presently he is working with the National Aeronautics and Space Administration to develop a productivity program for the space shuttle, which sounds quite exciting. He is a graduate of the University of Florida with a B.S. in Metallurgical Engineering, an M.S. in Production Economics, and a Ph.D. in Industrial Management. It gives me a great deal of pleasure to introduce this session's Chairman and the conference Co-Chairman, Dr. Jim Tweeddale.

Dr. J. W. Tweeddale

Peter Drucker has stated that two things are organic to every organization. Those are change and managers. It's not a question as to whether or not they occur, but a question of in what direction they occur and who controls the process.

Harlan Cleveland, the former President of the University of Hawaii, stated quite succinctly, in looking at the array of problems that confront managers in trying to introduce beneficial change into organizations, "How do you get everybody into the act and still get something done?" Really, I guess that's a challenge for management today. We've heard an awful lot about productivity as an output measure of innovation and certainly it is that. Quality Circles and other such social technical systems provide a structure, a mechanism for managers to tap into to create a mentality of the work force.

I like to think of productivity in a very generic sense as really the management of beneficial change into the mainstream of organizational life, because beneficial change must occur

if we are to improve productivity. We heard in this morning's and yesterday's sessions a number of specific thresholds of opportunity that are there for managers to consider as they explore avenues of productivity enhancement in whatever organization, public or private sector, whether it's a staff or line management position. Many of the systems of management that were discussed, many of the technology-oriented improvements, apply to either a direct or an indirect staff or line production type operation.

In this afternoon's session, we have really a wrap-up session. We are privileged to have highly credentialed individuals from academia, people of the industrial world of work, that provide specific methodologies that have proven effective, both in public sector and private sector organizations to consider issues such as how do you measure productivity. There were questions raised yesterday and also this morning about measuring productivity in engineering, as well as in direct labor organizations. We have some people who will be addressing those issues, as well as some of the specific productivity enhancement methodologies that managers can consider when looking at, particularly, the indirect type organizations.

I'd like to move right on with the session. Perhaps we can present the entire session before we have this mass exodus to the airport later on this afternoon.

Our first speaker of the afternoon is Dr. Sumer Aggarwal, who is a Professor of Management Science and Operations Management at the Pennsylvania State University. Dr. Aggarwal received a B.S. degree in Mechanical Engineering in India and a Ph.D. in Production at the University of Moscow, USSR. He did post-doctoral work in Industrial Management at Harvard University. He is a UNESCO Fellow, 1958-1961, a Ford Foundation Scholar, 1965-1966, a Visiting Professor at the National University of Malasia in 1978, a Senior Visiting Fullbright-Hayes Professor at the Soviet National Institute of Management in Moscow, USSR, 1979. He has been a distinguished visiting lecturer for Finished Materials Management Association in 1979. He has published two books and is presently working on a third book, all of which deal with subjects of relevance to the issue of productivity management. He is presently assigned in the Naval Material Command Productivity Management Office on an Inter-Governmental Personnel Act assignment, and in that capacity he is doing some very interesting work in Quantification of Productivity, how you measure it, how you evaluate your effectiveness in supporting a mission. Dr. Aggarwal has published more than 65 articles in major journals and he has visited more than 50 countries on a global basis around the world on more than one occasion, visiting with heads of state as a consultant. He has been listed in American Men and Women of Science, Who's Who in

Education, and in the Dictionary of International Biography. It is indeed my pleasure at this point in time to introduce to you our first speaker of the afternoon, Dr. Sumer Aggarwal.

Dr. Sumer C. Aggarwal

Thank you, Dr. Tweeddale. I hope I can live with the type of description you have given about me.

This afternoon I am going to present two points of view. Before going into the details, let me declare my conclusions and then I will build up on what I am trying to say.

The first thing I would like to build around is there is no productivity improvement if there is no measurement. Otherwise, it's all fun and games.

Second, there is no single action or single element or factor which will improve the productivity. There are many, many factors which need to be addressed, and I have been listening and that's good. But some organizations focus on one factor - get productivity - and fine, that part is okay. But if someone is thinking there is a majic wand or there is some single factor which will lead to improvement of the productivity, there is no such thing.

In my description today, I am going to give many, many examples and you might get an impression that I always talk about negative things. Please excuse me, because being an analyst and when your focus is on improving productivity, somehow this becomes a habit to ignore the positive things and look at the negative things. That's an unfortunate habit of mine and that will be in the lecture, too. That does not mean the organizations and the companies about which I'm talking do not have positive things. There are many good things, many positive things, and probably if I go on that side I will not be able to list where the losses of productivity are taking place.

So these are the two issues I am going to build upon - what is productivity; without measurement there cannot be improvement. Second, there are many factors which can improve productivity and the third, I think, what are the different ways and which are the pitfalls to be avoided by the managers while trying to improve and enhance productivity of your organization.

First, let me give you some basic data. This morning a speaker was telling about 72 percent of our working force is indirect work force. Only 28 percent is in manufacturing industries and out of that 28 percent, 14 percent is direct labor and the other 14 percent is indirect labor. So we are practically dealing with about 86 percent of the indirect labor force and out of that, I think when we calculate our GNP, we

always account for the productivity or productive efforts of the Government, which constitutes these days about 32 percent of our total GNP, which is in the neighborhood of $2 trillion. And in the Government, we must underline, except Defense, who are preparing themselves to fight war, all the other staff are indirect labor and is doing non-productive work. It does not improve the quality of life. It does not add to the services to the population; in a fringe way, it may. But that 32 percent is there - the national income going to the Government expenses, though they claim they are providing an extremely large number of services. There are services, we cannot deny that - transportation, airports, communications - and there are some other things which the Government supplies, but that is not the dollar value of those services which the Government consumes. But many people criticize the Government. Let's move from there to the next thing. (Fig. 1)

Here I am giving you some basic definitions of productivity from the economist's point of view. The first definition is, productivity is not a buzz word. It's something good, but in the basic sense, you can say deficiency; you can say defectiveness. There is always confusion in the minds of many of us. Productivity from the national point of view and productivity from the company or organization point of view are two separate things. (Fig. 2)

When you are talking about the nation, we can always measure output in dollars in terms of shipments and divided by total man-hours. That has been the economist's definition. And over the last eight years, what has been happening? They have been substituting labor for machinery and automotically, output has been going up, man-hours has been going down, and everybody says productivity for the nation has been going up. To that extent, it's all right. We should not close our eyes today. This country is at a saturation state and this morning they were talking about the future of the factory, automation, robotics, and all those things. Let's not forget one thing. Some of you who read The Economic History Journal, it has been mentioned there and a graph has been plotted that when, in any nation, the unemployment rate reaches about 30 or a little more, the revolutions take place. This is the historical truth of all the revolutions during the last 400 years. So those people who are going to eliminate the work force altogether should be considering what are these people going to do? Are they going to dance halls? Massage parlors? Playboy Clubs? Fishing? That cannot be, so we cannot have this completely automated factory without ignoring the fact that if our unemployment rate goes very high, we should take into account the historical fact - 30 or 35 percent unemployment rate leads to revolution and I don't see how and why we can ignore that sort of historical truth. (Fig. 3)

EMPLOYMENT IN U.S.

28% IN MFG & EXTRACTIVE INDUSTRIES

HALF OF 28% IS DIRECT LABOR

72% IN SERVICE INDUSTRIES

32% OF GNP IS IN GOVT.

FIGURE 1

PRODUCTIVITY = EFFICIENCY
= EFFECTIVENESS
= WORTH

AGGREGATE PRODUCTIVITY (NATIONAL) = $\frac{\text{OUTPUT IN (\$)}}{\text{TOTAL MAN-HOURS}}$

PRODUCTIVITY (COMPANY OR ORGANIZATION) = $\frac{\text{TOTAL DESIRABLE OUTPUTS (\$)}}{\text{TOTAL INPUTS (\$)}}$

LABOR PRODUCTIVITY INDEX = $\frac{\text{TOTAL DESIRABLE OUTPUTS (\$)}}{\text{TOTAL LABOR INPUTS (\$)}}$

MATERIAL PRODUCTIVITY INDEX = $\frac{\text{TOTAL DESIRABLE OUTPUTS (\$)}}{\text{TOTAL MATERIALS INPUTS (\$)}}$

CAPITAL PRODUCTIVITY INDEX = $\frac{\text{TOTAL DESIRABLE OUTPUTS (\$)}}{\text{TOTAL CAPITAL INPUTS (\$)}}$

O.H. PRODUCTIVITY INDEX = $\frac{\text{TOTAL DESIRABLE OUTPUTS (\$)}}{\text{TOTAL O.H. INPUTS (\$)}}$

FIGURE 2

STEP 1

MEASURABLE GOALS ?

- OUTPUTS
- COSTS
- TIMELINESS

EXAMPLES:

1. UNITS OF WORK PACKAGES COMPLETED
2. DEVIATIONS FROM SCIENTIFICALLY ESTIMATED COSTS
3. LATENESS

IMPOSED GOAL BY LAW:

A. SAFETY

B. ENVIRONMENTAL

C. BUDGETARY

FIGURE 3

Next, I will try to define aggregate productivity nationally. Output in dollars for a company can be measured. Some of us talk about can we measure the output of a Government agency. No, not directly, because we cannot put on it a dollar value. But there are indirect ways of measuring anything and that's not impossible. We'll give you an example a little later. But, surprisingly, inputs can always be measured in dollars because anything we would build, you spend dollars. Input is very easy to measure for any company, any corporation, any organization, any Government department. But together with that, economists and accountants use these four other indices of productivity - and these are important because they tell us which particular part of an organization needs the most important thinking, most important analysis. We should not be blind to the fact that if you are spending only 10 percent on labor and we are focusing all our efforts on labor productivity, that's a totally wasted effort. If overhead costs are 75 percent, I would say any manager should look at this overhead productivity index, because if labor costs you only 15 or 20 percent of the total input, then whatever he does, his imporvement on that 20 percent is going to be very, very small. That's why these four indexes have been designed and each index is total desirable output - and I must underline the word desirable. Suppose you are a company and you are producing something - let's say, reinforced concrete bars. The construction industry is not picking up all your products. Then, there is no desirable output. Desirable output means what you produce can be sold. Today, the oil refineries lack of oil is definitely - for them, it may be desirable output. There is some speculation, there is some holding, but still they don't want that oil to be lying there in the reservoirs. So desirable means that which can be sold immediately. And that's why these four equations are there.

Let's move on. The next step, which is very important and most difficult to deal with, is that we must be able to define our outputs. First, measurable goals and then work them to outputs - and this is the job of the intelligent manager. Can he do it or is he fumbling around writing a job description or the objectives of the corporation in 250 items, not knowing which one is good and which one is bad.

Let me tell you a story. In the Soviet Union, economists have designed a system where every plant manager is required to report approximately 3,000 indexes every month and while lecturing in Moscow - it was to a group of 600 managers - two or three times this question came up. Do you think these 3,000 economic indexes we are using are of any value? Thought there were some top economists sitting there, I said, "They are completely worthless." Any measure which takes into

account more than 5 to 10 items of a particular organization becomes worthless because firstly, filling out those forms, including 3,000 measures of no value, and then the real, marginal input from only 5 or 10 measures can account for 80 percent of our total input and total output. So there is the real trick. While you are trying to double productivity measure, you should be able to translate goals into realistic output which can be measured. Measurable output. And then we should also, in our efforts to measure, be always worried about costs and the timeliness of those goals. We cannot ignore it. If you can put into your output measurement and convert them somehow into dollars - some people will question that it is impossible. It is not workable. It is not sensible. It's not logical. All sorts of arguments are there.

Let's think for a moment intelligently. I think every manager is capable of finding out in his system, one, two, or three measures of output which are more or less, perhaps plus or minus 5 percent basis, measurable and reflect the real output of the system. That's not impossible. You talk to the managers. Listen to them. They will tell you, "This is what I want to be done. This is my first priority." They know it, but many times the discussion is that it cannot be measured. This is, I think, a helpless situation. Everything can be measured if the manager is willing to talk it out and he can specify the priorities of the output from his company or the organization

Let take a case where examples are taken, units of work packages completed. Right here in NARF, there can be always a definition of work packages, and every work package may have a weight attached to it. Shipyards, which were supposed to be one of the most difficult things to measure, now they have, some of you might know, the "swillens and swabs." These are nothing but work packages. Every work package has been defined. Some man-days, man-hours have been identified. Parts going into that particular repair or overhaul item are known. So they have a measure there. Now, at least this is a beginning. It may be crude today, but after two years, ten years, these measures will become real well-defined outputs. And this is making a start on how to measure productivity.

Next we move on to deviations from scientifically estimated costs. If you cannot measure the real output, another way of measuring - because every company starts with an estimate or a budget, and in that case, we can start measuring the deviation. Actual deviation from those estimates which have been prepared by the cost accountants or the budget people. Unfortunately, in some Government organizations I have seen the deviation from the budget estimates is either -30 percent or sometimes +100. Now, this is a really

ridiculous measure of output, but still, if this measure looks very high, here we are checking on the deviation from the scientifically measured output or estimated cost. So this is called surrogate measure for the productivity and how best they are doing it. Then lateness could be a negative measure.

Now here I come to, I would say this is unfortunate that, particularly in Government sectors, people are supposed to be if not Gods, equal to Gods if they are to get promotions. Yesterday at the lunch hour, Dr. Currie was sitting by me and he told me a fancy story. He said that one time when he was in DOD, he wrote a report for a Colonel, and he wrote that he was outstanding on four or five counts, but he needed improvement on one factor. Immediately, a General came back to him and said, "Look - you have destroyed this Colonel forever. Why don't you change this report," which he did. And then he found out that if there is any mention of weakness, then automatically, people are very defensive. Now, nobody's perfect and we should be looking at weaknesses. This is what I'm saying with regard to lateness. Lateness is a weakness. We can measure the output of productivity of a particular organization if time is of critical importance. So now, my output is number of documents, number of pages, page days late. Now, that is a starting point. Later on, we may find a better measure. Then there are certain things which generally seem to be reducing the productivity and people try to lay all the blame on those things. For example, they say safety is imposed by law and here we are trying to improve safety, so are these adding to productivity or decreasing productivity. Many times people blame safety considerations, environmental considerations, budgetary considerations - these are the biggest losses of productivity; yes, they are. But let me tell you a truthful thing. I took out all the amounts which the shipyard had spent on these three, or similar imposed overheads, legislated overheads. They were less than 7 percent of the total cost. So this is a mirage in the minds of many people that many of our losses in productivity accrue from the legislated overhead or from the laws of the Government. That's untrue. There is some truth to it, but that's a very small fraction.

Now, we need to translate our goals to outputs. These are some of the examples. No doubt I have said work packages. Man-days on maintenance work package. Units of sickness. That reminds me of an example. Anyone today in some hospitals know that the unit of measure is bed-days occupied by patient. That is considered the efficiency of the hospital. If he wants to improve the number of bed-days in a hospital, the doctor should not discharge the patients. If there are no patients coming in, he can keep the old patient there and his occupancy or bed-days will be very high. Productivity is high. So now

people are changing to units of sickness cured. They have a system in many hospitals that appendicitis cured is earning 10 points. A simple tonsillitis operation earns 5 points. A person with influenza earns 2 points. So now, the measure has changed and it's a sensible measure. This is where the manager makes mistakes. In the past, the same hospitals were using sick bed-days. And automatically, who was suffering? The patient was suffering. He was kept in the hospital for a long period of time. (Fig. 4)

Let's move on to the next. Number of rated criminals punished. There was - and this is true - Kansas had a law that the police officer's productivity would be measured on the basis of number of arrests made or number of those citations issued. So, police officers were very active. They used to make many arrests and it was a very productive officer's club. But later on they found that was for the purpose of the police officer. So then they said the number of rated criminals punished. Different crimes had been rated on a scale of 1 to 10 and people who can be actually convicted in the court determines the productivity of the police officer - not the number of forms he fills out; not the number of citations he issued. So here is another good example of how you can measure productivity. Units of fire control - level 1, level 2, level 5, etc., so in fire departments, productivity should be measured by the number of units of fire alarms control, not the response time, which used to be a measure. It's important that response time be kept to a minimum - maybe 3 minutes, 2 minutes. But at the same time, the productivity of the Fire Department is not to be measured based on how much time it took for response. It should also be measured on how many units of fires they controlled. Then units of rated accidents avoided. This is again in case of traffic police - not the number of citations written or tickets issued - accidents avoided. The units of linen washed in a hospital or a hotel - different linen items are there so you can give each piece points - a sheet, 2 points; a towel 1 point; a hand towel 1/2 a point. Here is a productivity measure. Some of you might be thinking that this is too much paperwork, too much accounting. I'll come to that. It's not difficult. One man can take care of it and there are living examples - one man can take care of a force of anywhere between 500 to 1,000 people working these service jobs. (Fig. 5)

Next I move on to units of meals served. People said you cannot measure the productivity that way. Averages tell us when you have a reasonable measurement scale and you take measure data on a large number of units, things average out. After all, why do we want to measure the productivity? The basic purpose of productivity measurement is identify those good managers versus bad managers and reward them. Second,

GOALS
MUST BE TRANSLATED
TO OUTPUTS

1. WORK-PACKAGES
2. MAN-DAYS ON MAINTENANCE WORK-PACKAGE
3. UNITS OF SICKNESS CURED
4. NUMBER OF WEIGHTED CRIMINAL PUNISHED
5. UNITS OF FIRES CONTROLLED
6. UNITS OF WEIGHTED ACCIDENTS AVOIDED
7. UNITS OF LINEN WASHED
8. UNITS OF MEALS SERVED
9. NUMBER OF PAGES WRITTEN
10. NUMBER OF FILES REFERENCED

FIGURE 4

COMMON ERROR IN MEASURING OUTPUTS

THE OUTPUTS MAY NOT BE IMPACTING THE GOALS

1. NUMBER OF FORMS FILLED BY THE POLICE OFFICER
2. NUMBER OF SNOW-STORMS FORECAST
3. NUMBER OF MILES TRAVELLED BY THE ENVIRONMENTAL AGENCY INSPECTOR
4. NUMBER OF HOURS SAVED BY THE REMOVAL OF COFFEE MACHINES
5. NUMBER OF DOLLARS AWARDED PER SUGGESTION
6. TIME SAVED AT TOOL CRIB, BUT WASTED AT MACHINES
7. QUALITY CIRCLE - HOW THEY ACCOMPLISH GOAL
   - NO FOCUS ON QUALITY
   - JAPANESE DO IT
   - UNDER PRESSURE

PROCESS SHOULD NOT BECOME THE GOAL

FIGURE 5

compare the performance from period to period. That's the only purpose of productivity - reward the people who are really productive and compare our own performance with respect to our past performance and with respect to the performance of our competitors. This is the whole purpose of productivity.

I have not yet gone to the question of how productivity can be improved. We are still entering that phase. The number of pages written - here I do not mean keep writing anything you want -- quality pages written - relevant pages written for a professor or even for a Government bureaucrat. That could be a measure. Number of files referenced - even that could be measured, and yet many people think it cannot be done. One person can keep track of 500 people and I think if one person can measure the productivity of 500 people, it's worth it, we should have it, because he is alerting 500 people - out of those 500, there may be 300 who are sleepy-heads. Now, they know they are being measured. They will check at the end of each week on their productivity, on their output. So they will start doing something; maybe it will be worthless, but as time passes, they will switch on to some good things and you will find the productivity going up. (Fig. 6)

I think I am going too far, but let's get into a funny example of number of snowstorms forecast. This was the worst type of output measure of productivity. Are we concerned about how many snowstorms are going to come? Actually, our forecasting department should be measured on the accuracy of the forecast and I think this is a living example. In Pennsylvania, they were measuring in their department the number of forecasts made. If there were no snowstorms, why was the productivity of the forecaster going down? The number of snowstorms is a natural phenomenon, so they should be measuring the accuracy of the forecasts.

This is a classic example and it still exists - the number of miles traveled by the environmental agency inspectors. For him it is gorgous because he gets mileage and he can travel every day 200 miles and inspect 3 places. They were not measuring what he inspected, what he corrected. They were measuring the number of miles he traveled. What an irrelevant measure of productivity.

The number of dollars awarded per suggestion. Now, this company - and I even found it in the Navy - they measured the productivity of the suggestion system program on the number of dollars awarded per suggestion. You can see how illogical that measure is.

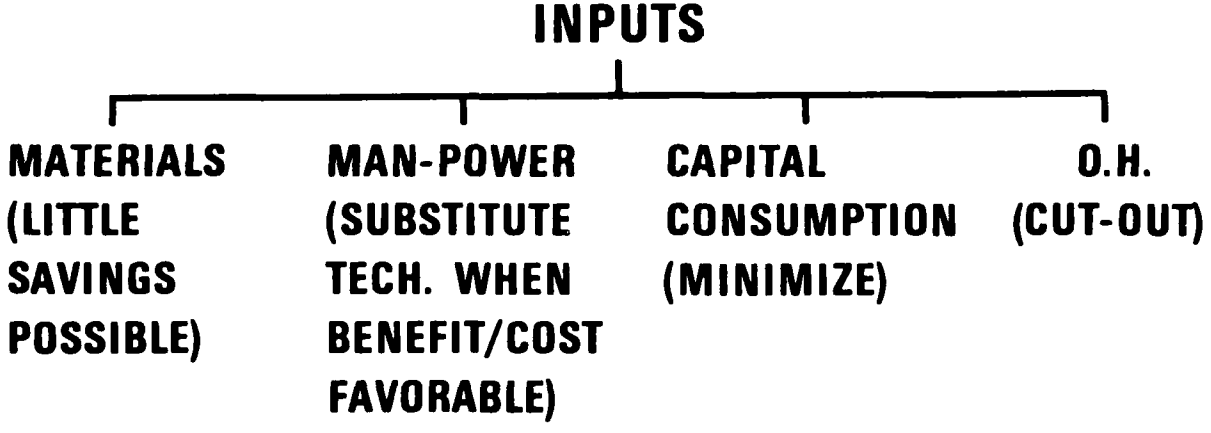
We have been listening too much about Quality Circles. I am a supporter of Quality Circles. But Quality Circles

INPUTS

ARE ALWAYS MEASURABLE IN DOLLARS, AS PER STANDARD ACCOUNTING PRACTICES.

MINIMIZE TOTAL INPUTS

1. **ARE THEY ESSENTIAL ?**
2. **HOW MUCH OF THEM CAN BE ELIMINATED**
3. **DO WE HAVE AVAILABLE CAPACITIES FULLY LOADED ?**



CONVERT MISDIRECTED O.H. TO DESIRABLE CONTRIBUTIONS (OUTPUTS)

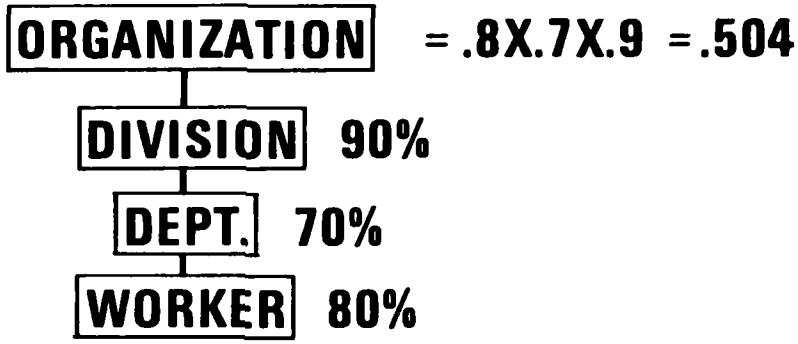
FIGURE 6

sometimes are completely misunderstood and used is a very clumsy way. Here is a published example. Quality Circle people got together and they found at the tool crib there is always a long line of workers waiting. The suggestion was if you ask these fellows if they are skilled workers and let them carry all the tools and deliver at the machines, the line disappeared. But instead of those people standing in the line at the tool crib, they were waiting for the tool at the machine. Idle time might have increased. Nobody even cared to understand that disappearance of the line at the tool crib is not a great accomplishment of Quality Circles. They failed to analyze or understand that the total system situation, when you are looking at a tool crib, look at who is idle. If the new system is installed, again, who is going to be idle. Yesterday, also, there were four or five suggestions given on Quality Circles. And most of them were either garbage-related or safety-related. Now, these are sensible suggestions, but there was not a single suggestion where quality has been improved or money has been saved. After all, I would consider that such suggestions, instead of coming through Quality Circles should be the responsibility of the foreman and he should be able to talk to the workers.

(The remainder of this presentation was not recorded.)

MEASURE PRODUCTIVITY AT MULTIPLE LEVELS

DEVEP CHAINS OF CAUSE-&-EFFECT FROM TASKS TO FINAL OUT-PUTS



BALANCING OF PRODUCTIVITY GOALS, TIMINGS, & FOCUS IS ESSENTIAL

65% TO 75% ARE O.H.
STILL WORKERS DO NOT HAVE SUPPORT

SECRETARIES OFTEN SAY: WE ARE THE BOSS

FIGURE 7

PRODUCTIVITY PROBLEMS

1. PLANNING WEAKNESSES
2. LAYOUT & MATERIAL FLOWS
3. CAPACITY BOTTLE NECKS
4. TRAINING OF PERSONNEL OR LOW COMPETENCE PERSONNEL
5. INCOMPLETE (AMBIGUOUS) INSTRUCTIONS
6. UNNECESSARY PAPERWORK
7. INAPPROPRIATE TECHNOLOGY
8. TOO MUCH EMPHASIS ON UTILIZATION OF RESOURCES (WHY WORK ON LOW-MARGIN JOBS)
9. LACK OF MOTIVATION
10. LACK OF FEAR OF NEGATIVE MEASUREMENT
    - A. CHINESE DOCTOR : ABSENTEE DAYS
    - B. RUSSIA : NUMBER OF REJECTS
    - C. INTERNATIONAL PAPER CO. POSTERS
    - D. ASIANS RELIGIONS : DEATH

FIGURE 8

LIMITATIONS CAN BE REMOVED

1. REMOVE ARTIFICIAL LIMITATIONS
   - A. DO NOT ORDER PARTS, TILL JOB-ORDER IS RECEIVED
   - B. DO PAPERWORK FOR EACH ITEM $50 AND ABOVE
2. CHANGE JUST TO BE FASHIONABLE IS WASTEFUL
3. TRY NEW IDEAS, ORGANIZATIONS ON PILOT BASIS. ASSES AFTER 1 OR 2 YEARS. IF MARGINAL DISCONTINUE. CHECK ON OLD PRACTICES.
4. PROMOTIONS LINKED TO
   - A. NUMBER OF SUBORDINATES
   - B. $ OF BUDGET
   - C. SUPPORT TO BOSS
   - D. MANNERISM & FANCY SHOWBUS
   - E. NUMBER OF BRIEFINGS

FIGURE 9

FUNNIEST EXAMPLE

I. $ 95 WORTH OF PRODUCTIVITY LOSS IN FEDERAL GOVT.

"DON'T" PROGRAM FOR PREVENTION OF SEXUAL HARASSMENT

REMOVE SINGLE EVALUATION BY SUPERVISOR LET THERE BE SOME PEER EVALUATION AND USER EVALUATION ALSO.

II. REMOVAL OF COFFEE MACHINES SAVED $9 MILLIONS WHAT IS THE SUBSTANTIATION ?

PRODUCTIVITY CAN BE MEASURED AND IMPROVED, IF MANAGERS ARE CREATIVE, KNOWLEDGEABLE, WILLING TO ACCEPT CHALLENGES, AND MOTIVATED.

FIGURE 10

Michael T. Midas, Jr.

I am privileged to be here today to share our thoughts on productivity issues in America. We strongly believe that the aerospace, electronics, and shipbuilding industries represent significant leverages for getting our productivity growth rate back on track.

I bring with me the prejudices of a young American, born and reared in the anthracite coal regions of Pennsylvania, and trained, educated, and influenced by the many wonderful Americans, ages 18 to 60, that I've had the privilege to associate with during 24 years of service as a line officer in the United States Navy.

During the past two years I have been totally immersed in industry and in the productivity/quality of work life issue. I have spent time on the American manufacturing plant production floor responsible for designing, developing, and executing what we called a Workmanship Excellence effort for 800 hourly workers, support engineers, and managers. This experience allowed me to study, observe, and learn the manufacturing processes and people from the supplier to the incoming dock, through production/assembly/testing, the product sale, through the consumer, and back to the research design and development area.

I witnessed the same kind of spectacular results during that experience as I had previously in a naval shipyard when focusing on people and processes.

During the past five months I have had the opportunity to travel throughout the country observing and studying people and processes. After making these observations and burning a little midnight oil, I have been trying to identify our most significant leverage areas for productivity improvement in 1981.

We recognize the total magnitude of the challenge before us. Perhaps we should spend time focusing remarks on the manufactured goods area. This is where, in our opinion, we in the U.S. are getting our socks knocked off today in the domestic and international marketplace.

We are confident service sector leaders can apply these same principles in their organizations.

With that background, let me direct your attention to the following areas during the next few minutes: observations and perceptions of where the U.S. presently stands on the productivity issue and the productivity-quality connection; measurement as an essential element of productivity improvement; how quality explicitly fits into the productivity measurement equation; and where do we go when we leave here today.

First, some general observations and perceptions with respect to productivity improvement in the United States.

Dr. Grayson and professionals from the Center assist organizations nationwide to develop a productivity perspective and results-oriented attitudes. We are often asked, "What have you found out since APC started in 1977 and where do you think we are today?" I want to share some general comments with you that may answer that question and provide some perspective for the remaining issues of discussion.

The good news is that the declining productivity rate has been talked about so intensely over the past several years in our country that it appears that it is now being generally recognized as a problem. Back in 1975, when Dr. Grayson was going around this country by himself talking about productivity, he said it was like saying, "The glaciers are coming."

The bad news is that talking about it doesn't necessarily improve it.

We see four stages of organizational awareness with respect to the productivity challenge.

Phase 1, the "in bed and sleeping" phase. Here, imagine the top leader of an organization in bed, sound asleep, and unaware of what a productivity perspective is.

Phase 2, the "in bed but awake" phase Here, imagine if you will, the top leader of an organization early one morning waking up from a dream. In that dream, the NBC white paper "If Japan Can, Why Can't We?" and the CBS white paper "The Toyota Invasion" each flashed 39 times through his mind. The value of that type of spaced repetition makes him aware that he might not really have a good assessment of his total organizational performance, that perhaps he needs to better understand his organization's present way of doing business, and perhaps there is need for a new organizational perspective.

Phase 3, the "awake and out of bed" phase. Here we see the top leader alongside the bed, putting on his trousers, thinking about getting organized and how he will approach and organize for the important challenge of improving productivity and the quality of work life.

Phase 4, the "out of bed and running" phase. Here we see the top leader with all his resources organized and moving towards a predetermined, worthwhile, measurable organizational productivity improvement goal.

We concur with Peter Drucker's statement that productivity is the first test of Management's competence.

In general, we see these specific barriers to productivity improvement. 1) Productivity has not been a discipline in the business world. 2) Many top leaders lack hands-on experience with the leverage points for productivity improvement. 3) Many top leaders push forward with a short-term earnings perspective. 4) If work is done on productivity improvement, top management often tries to attain too much, too soon, without proceeding through the substantive awareness, strategic planning, and thorough and detailed assessment phases required for adopting a productivity perspective. This results in too many false starts. 5) Too many times, the responsibility for productivity improvement is delegated to an individual or unit without the involvement of the top leader. The staff level of the person put in charge of the productivity effort is a signal for the organization. 6) Productivity is implemented as just another program. These barriers are general and certainly not all-inclusive. But hopefully, they provide a proper perspective for our next point.

Now, some general observations on the productivity/ quality connection in the U.S. This topic, the "Productivity/ Quality Connection," isn't as visible, glamorous, or intriguing as Quality Circles or Employee Suggestion Systems, or styles of management, which seem to be major topics of conversation throughout the United States today. I want to share with you our perception of the Productivity/ Quality Connection with regard to measurement elements and I assure you I will not speak in esoteric, economic rhetoric.

Dr. Demming, known by many as the father of the Japanese quality movement, laments, "Nobody seems to understand that as you improve quality, you improve productivity."

If we think for a moment, the key word is understand. If something is good and we understand it, then perhaps we take action and see results. In Japan, quality and productivity are almost synonymous. They see the by-product of quality as productivity and they have taken action and achieved results. In the United States, quality and productivity are too often regarded as distinctly different issues, having very different meanings. To a significant degree, quality isn't defined or measured.

Recently a group of manufacturing company presidents met at a Manufacturing/Productivity conference in a major city in the United States. There were ten speakers who held either Chairman, President, or Senior Vice President positions. Here are some of the areas they detailed in their presentations.

1. A Value Engineering program and how an Employee Suggestion program contributed to it.

2. A productivity, joint management/union council, replacing an ineffective suggestion system.

3. Employee involvement to reduce institutional impediments to productivity.

4. An effective utilization of material review panels within a high technology environment.

5. Operator training and replacing inequitable incentive systems rough a Manufacturing Effectiveness program.

6. The importance of sharing marketing goals with all employees and an open-door policy for all levels of management.

7. Profits to provide funds for capital investment

8. Adversary relationships between manufacturing and government had esulted in excessive overhead

9. The planning and expenses incurred in the first year of a Quality Circle program.

Now that's nine items. Did you hear anything that was explicitly missing in there? Did you hear one time where productivity improvements through a focus on quality was mentioned?

Fortunately, there was one other speaker. Dick Craft, President of Matshusita Electric Industries (M.E.I.), reviewed the positive results obtained from placing emphasis upon quality by a Japanese company operating in America. He reviewed the old familiar numbers that have been around since 1976, two years after M.E.I. (Quasar) acquired the Franklin Park, Illinois facility. Defects were down to 5 per 100 TVs, from 130 per 100 TVs. Warranties were down to one-tenth the 1974 level. Productivity was up 30 percent.

From a bird's eye view, the approach that Dick Craft outlined at Quasar demonstrates the great impact a quality strategy can have on productivity improvement results. It represents a significant opportunity in the 1980s.

Again, in Japan we know that the terms "productivity" and "quality" are nearly synonymous. In the United States they appear to be driven by different drivers. But the question arises, shouldn't there be just one driver? And if we believe that quality begets productivity, who should that one driver be in the organization?

We know of some positive examples and attitudes by top leadership. 1) ITT - 1965 to 1979, Harold Geneen, Chairman and President. Phil Crosby, Vice President for Quality in 1979 reported that defect prevention saved ITT $719 million in 1978. 2) General Instrument Corporation - Chairman, Frank Hickey, is so convinced that quality, straight through to the bottom line, is the key that he said, "Managers are graded on the quality of

the products for which they are responsible. There is so much that is abstract about quality that unless you put it in profit-loss terms, it isn't as motivating."

There are other companies that recognize the leverage for productivity improvement through a quality focus. RCA with their product reliability, Texas Instruments, Sygnetic Corporation, National Semiconductors, Hewlett Packard, and the Nashua Corporation all have something in common and you know what that is. They are in a highly competitive market.

I would be remiss if I didn't mention the focus on supplier quality by the President of Ford Motor Company when he talked to his suppliers at their Annual Conference in April of last year. He crystallized the standards set by the Toyota Production System, "Just in Time," using the "KABAN" information system. He noted that Toyota considered one hour of in-process production inventory adequate. He stated that although it varies considerably with the plant and the product, in some cases we have in the United States as much as two or three weeks plant inventory in our system. If you haven't already, you might just want to review that Toyota "Just in Time" Production System.

The purpose of those examples is to make a point that the industries that seem to be at least focusing on quality for productivity improvements are the automobile, electronic, semiconductors; those that are aggressively being challenged in the marketplace.

I visited with Dennis Ossala, the Director of Operations at Quasar, on the 24th of February. He is a Plant Manager who is involved in the Productivity-Quality Connection. His involvement is visible from the charts on the walls of his conference room and in the various levels of his organization. He does not need to describe the connection because it is right up on the walls and visible. The quality measurements are on the left and front, and productivity on the right - three years of measurements for everyone to see.

I noted earlier the good news is that the productivity decline is becoming recognized as a problem in this country. Ladies and gentlemen, we have some more good news today. Focusing on a quality strategy for productivity improvement represents a significant positive opportunity for each and every one of us in 1981.

People talk and write today about many issues that exist and hold us back from significant improvement in the quality area: management, union organization, lifelong employment, total quality control, Quality Circles, language, burn-in times, automation, vertical integration, layer design teams, and a host of others. But let us focus, for a moment, on just two: management and total quality control.

Let's take total quality control first. Normally, our production people (I'm not saying productivity people, but production people) set goals of meeting schedules and getting products out the door. Quality people set goals of ensuring product quality. There is a natural tendency for an adversary relationship here - pervasive in our society, reference government vs. industry, labor vs. management, production vs. marketing, production management vs. quality management, and last but not least production labor vs. labor associated with a quality control function.

Without a doubt, both production and quality organizations should be moving towards a common goal; that is, producing a product that meets specifications with minimum waste and delays. There is no question that the two working together as a team can achieve a worthwhile common goal much better than one taking one route over here and the other taking another route over there. I submit this is a major challenge facing us today. We're not together moving toward a common goal. The end result can easily be predicted. If we in staff positions go to our manufacturing arena and see what is happening between the production people and the quality people, we'll understand this observation. Even at Quasar, it was present when Dennis Ossala took over his job three years ago.

Observe specifically what happens when it's time to give the product its final blessing and before it goes out the door. Without an attitude that reflects quality as everyone's responsibility (total quality control), there is little chance of us maximizing our ability to have smooth-flowing, functioning processes with maximum productivity.

Dr. Demming states it succinctly as, "You don't get ahead by making products and separating the good from the bad because that's wasteful. It wastes time of those who are paid wages and it wastes time on machines and it wastes materials." That is a result of not doing things right the first time. It is not an example of total team quality responsibility.

Perhaps it is a reality in the United States that participation and responsibility for quality are still, in most cases, the responsibility and property of the quality department. In other words, maybe we still have the wrong driver to make productivity and quality synonymous.

Perhaps the driver has fallen asleep.

Perhaps if we had more specific definition of quality, this wouldn't be the case. We could better make the connection and take more advantage of this productivity leverage point.

This is what I'm going to do in the next two points -- Productivity Measurement and the Productivity-Quality Connection. I want to offer a fresh approach and hopefully create a gentle fresh breeze through our gathering here today. I suggest

we test the soundness of our concepts and the logic of our reasoning as to how we define productivity and quality. Let's examine what elements are used to measure them and how each of us makes the connection.

The American Productivity Center promotes a "state of mind" that recognizes productivity growth as the bedrock of our prosperity and ultimate national strength.

We believe measurement of productivity is essential to getting our manufacturing and service industries back on track as to productivity growth rates. Measurement transforms rhetoric to definition which can be measured. How do we know where we stand if we don't have an in-place credible productivity measurement system? The answer, from the thousands of annual reports in this country, might be profitability. At the entrance to the American Productivity Center we have a 39-foot high mural showing a stack of enlarged annual reports. That mural makes the point that perhaps profitability doesn't tell the whole story considering the U.S. competitiveness in the international marketplace. Perhaps we need to examine why we are profitable and if we are on stable ground.

There is a clear, concise, mathematically sound relationship between profitability and productivity. It is, profitability = productivity x price recovery. This slide shows that relationship and how it was developed. It's that relationship that tells us whether our profitability improvement or decline comes from a change in price recovery or in productivity. If we don't know the answer to that question, then perhaps we don't know whether we are part of the solution to inflation or part of the problem. Further, if we don't know, we will be in very difficult straights when we have to compete against some of our more productivity-minded competitors.

In one of Dr. Demming's papers, he referenced a Wall Street Journal editorial of June 27, 1979 that stated, "Rising inflation has a silent partner, declining productivity." Further, he says, "The penalty that every American pays in high prices because of waste and delays in industry defies measurement." Certainly he has no hangup with the importance of productivity to future economic growth. For the past three years, the American Productivity Center has conducted seminars for over 3,000 people from industries and organizations throughout the United States. In each one of those seminars, that particular relationship, profitability = productivity x price recovery, has been developed, explained, and emphasized as the basic rationale for productivity measurement. We've seen some action but not nearly enough to allow us to become the slightest bit complacent here. You can find in Industry Week of January 26, 1981, some specifics on this system.

Many rationalize today that productivity measurements commonly used don't take quality of output into account. Maybe we've been looking at the wrong part of the Productivity equation. Let's focus on the input now.

How does quality fit into the productivity measurement equation? First, the question is, do we agree that waste and delays defy measurement in our country. Let's respect Demming's wisdom and assume it is true even though it may require a future assessment of our own people and processes, whether we are in the manufacturing goods or service area. Now that we've made that assumption, what do we do next? If we want to improve, we need to measure where we are today, we want to set some goals and then track our performance. Further, we need to measure and track quality to ensure it is producing positive effects on productivity which we define as output over input where input = labor + capital + material + energy. It is positively clear to us, that a clear definition of quality is required before we can understand why improved quality gets us improved productivity and then take actions to improve.

Maybe we need to go back to the basic fundamentals. Here is the simple figure that Demming used in the early 50's in Japan. It shows the manufacturing cycle: supplier materials, production/assembly, inspection/testing, consumer research and service, design and redesign of product and processes. Now let's define some of these areas on this slide.

First, let's talk about this production area in here where the product is actually made. That is what we, at the American Productivity Center, call production quality and we define that as a level of production efficiency in meeting the specifications increased by eliminating waste, delays, and poor workmanship. It's variable and we believe it offers a significant leverage point for productivity improvements during the remainder of the 1980's. We believe that's what Demming was talking about when he said, "You don't get ahead by separating the good products from the bad products at the end of the line."

Now, what about product quality? We define product quality as a level of relevance, uniformity, and dependability satisfactory to the customer increased by better design specifications. And where are the specifications defined? They are defined up here in the design and the redesign area.

So, now we have broken the picture into two areas and this is a very important issue to us in that we have been talking too generally about the term quality and not specifying quality of what and who makes it, thereby never getting down to the important issue of measurement and responsibility for improvement. The way you improve the quality of a product is to better the specification and that's done up here by the design people, the engineering people, with inputs from the marketing people. Down in this section, the production section, we are talking about production quality. Not product quality. There is nothing

PERFORMANCE MEASURES

OUTPUT VALUE	=	QUANTITY SOLD	x	UNIT PRICE
"PROFITABILITY"	=	"PRODUCTIVITY"	x	"PRICE RECOVERY"
INPUT VALUES	=	QUANTITY USED	x	UNIT COST

PRODUCTIVITY IS.....

$$\frac{\text{OUTPUT}}{\text{INPUT}}$$

$$\frac{\text{OUTPUT}}{\text{LABOR} + \text{CAPITAL} + \text{MATERIALS} + \text{ENERGY}}$$

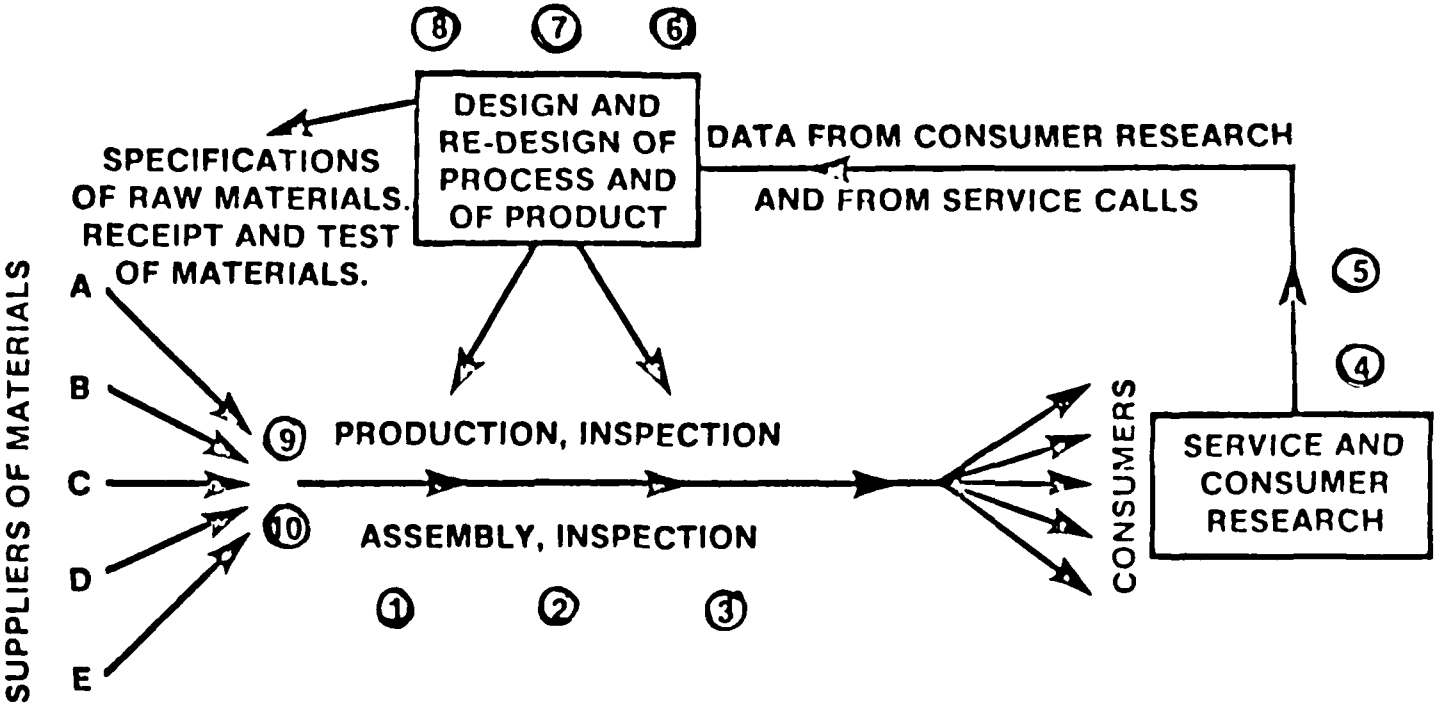


FIG. 1. THE PRODUCTION-LINE, FROM DESIGN, RAW MATERIAL TO THE CONSUMER. DATA FROM CONSUMER-RESEARCH AND FROM SERVICE-REQUIREMENTS PROVIDE A BASIS FOR RE-DESIGN OF THE PRODUCT AND FOR CHANGES IN THE REQUIREMENTS FOR RAW MATERIALS AND IN PRODUCTION.

THIS FIGURE TAKEN FROM A PAPER BY W. EDWARDS DEMING, *A LESSON IN INNOVATION FOR ECONOMY AND QUALITY IN PRODUCTION.* THIS FIGURE APPEARED IN LECTURES TO TOP MANAGEMENT IN JAPAN IN 1950.

NUMBERS 1-10 ADDED BY APC.

that the people in there can do about that specification. They keep reworking, they keep doing it, they keep making it until it meets the specification, and when it meets the spec, it goes out.

Now the question is, what do we measure so we know we are improving productivity? This is the control point on the critical path to successful results.

Let's stop for a moment and consider a gentleman that some have called the greatest change agent of our time, Pope John, the Pope of the Catholic church in the 60's. As you may or may not know, he didn't come up through the ranks. He was brought in as an outsider who was not conditioned by the association of working up through the normal organization. As I understand, he called his top management staff together and imagine the dialogue going something like this.

The Pope said: "What can we do for the youth of the world." There was silence.
He said: "Let's have an ecumenical conference next year. Bring everyone together. Talk it over. Maybe they have some answers."
They said: "Impossible. It would take ten years."
He said: "Break it up into 39 pieces and do one at a time."

They executed it in three years. The details may not be exact, but the concept is correct, as I have heard from one who was there.

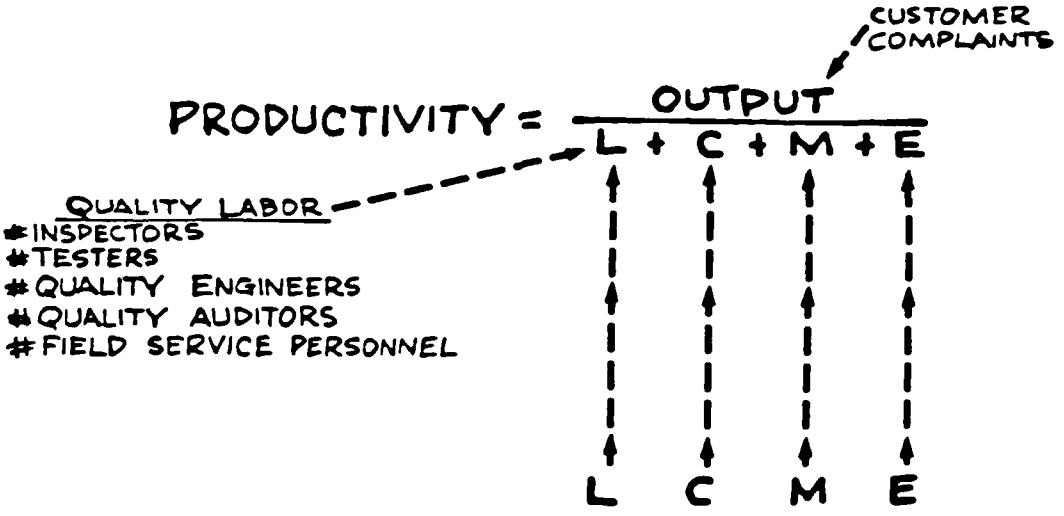
Let's break up production quality and product quality and see where they fit in the productivity equation. I think in general all of us believe that quality begets productivity. We could all describe how, if a machine operating within its parameters was running 24 hours a day putting out conforming products, and if all operators were in fact doing everything right the first time and putting out conforming products, then in fact, productivity would increase. To understand and internalize it, let's look at the measurement elements.

First, rework: for every defect or error that we have to do over, it takes extra labor or machine hours. Extra hours decreases productivity.

How about scrap and waste? Focusing on eliminating scrap/waste? Focusing on eliminating scrap/waste allows us to decrease the material required and that's increased productivity.

How about warranty? Focusing on measuring for a reduction in warranty can result in decreased material costs and labor costs for those who had to fix the defective product in the field.

"THE PRODUCTIVITY-QUALITY CONNECTION"



		L	C	M	E
1	REWORK (DEFECTS)	✓	✓		
2	SCRAP			✓	
3	INCORRECT INSPECTION	✓	✓		
4	WARRANTIES	✓		✓	
5	SERVICE CALLS	✓			
6	ECO'S	✓		✓	
7	PCO'S	✓	✓	✓	
8	SOFTWARE CHANGES	✓	✓	✓	
9	SUPPLIER REJECTS	✓		✓	
10	DAYS LATE	✓	✓		

SIMPLY STATED...

"DO IT RIGHT THE FIRST TIME"

How about service costs? Focusing on measuring for their reduction results in decreased labor costs again, and in increased productivity.

How about engineering change orders (ECOs)? Focusing on doing those right the first time in design and development could be one of our bigger leverage areas.

We all recognize that some ECOs are necessary but the question is, how many? The U.S. Navy had a $2.8 billion overrun charge against it from private shipyards several years ago. One of the complaints of the shipyard was that there were so many engineering change orders coming down on the shipbuilding process that missed completion dates and cost overruns were a natural result. Naturally, arguments resulted concerning the contribution of those changes to the cost overrun. Responsibility was the issue.

Now what about supplier rejects and supplier days late on deliveries? The foremen that I've observed in some of our industries have masters degrees. Masters of the "work-around." Providing materials any other way but right the first time and on time must become unacceptable to us. Clearly, Japan has organized and mastered this. That's why I recommended earlier that you study the Toyota "Just in Time" production system. We need to start measuring improving and working with our suppliers. It won't be easy. Quasar has 90 percent of their suppliers certified now. It took seven years and much hard-nosed leadership to get there.

I hope returning to the basics in this way enables us to better understand how quality improves productivity, the importance of measuring both, and how this basic figure can allow us to focus our efforts. Management must understand what is involved in the never-ending cycle of improved methods, of manufacturing, testing, consumer research, and redesign of products. We believe we need to focus our efforts on all these elements simultaneously before diving into quality circles or some other techniques. What good are quality circles if we don('t understand the whole system?

Let's summarize. First, definition is a dilemma in the U.S. Quality is....? Production quality or product quality - which is it? We suggest being specific by defining. Production Quality = a level of production efficiency in meeting the product specifications improved by eliminating waste, delays, and poor workmanship. Product quality = a level of relevance, uniformity, and dependability satisfactory to the customer, improved by better design specifications.

This focus is to define elements for measurement and fix responsibility for corrective action.

This slide shows the Productivity-Quality Connection. The American Productivity Center equation is on the top. P = output over Labor + Capital + Material + Energy. The product quality and production quality elements to be measure, all expounded on in Phil Crosby's book, "Quality is Free," are listed vertically here. The checks indicate the quality elements that affect productivity. This slide clearly depicts the Productivity-Quality Connection and allows us to demonstrate how a quality strategy explicitly affects productivity and emphasizes the importance of doing things "right the first time."

Rework, scrap, inspection errors and inaccuracies, warranty, services, engineering change orders, software changes, purchase order changes, supplier rejects, supplier days late, as well as the cost of inspectors, quality engineers, audit teams, and others explicitly affect the inputs to the equation. Perhaps we have neglected to focus on the quality impact on the input side of the equation for too long.

I also hope that I have provided recognition that we can get our productivity growth rate back on track faster with production and quality organizations working together toward the common goal, rather than going their ways separately and in an adversary manner. And that requires the top leaders' involvement. It's not important who it is, but rather that someone is driving for results.

It is important that we do not take all of the 80's to relearn the lessons that research of the zero defect efforts of the sixties taught us. As Phil Crosby stated so eloquently in 1970, "Our managers must understand the zero defect concept and recognize that they are dealing not with worker motivation but with management's attitudes and standards."

Where do we go from here? We believe that 1981 needs a recommitment by the people who hold our success in their hands; the CEOs/ COOs/Group Vice Presidents/Division Vice Presidents, and Plant Managers. We shouldn't expect miracles. We need to make sure we know what to copy from Japan. We need to understand what is involved in the never ending cycle of improved methods of manufacturing, testing, consumer research, and redesign of products.

Step 1 is understanding and believing that productivity and quality of work life are two sides of the same coin and we are not going to solve our problems overnight. We need to identify sloppy, slipshod work and acceptance of mediocrity all throughout our organization and so something about it for the long run. That means long range defect/effort prevention attitudes. There are some strong indications that we have been complacent for at least 13 years or more. It will require a productivity perspective based on awareness, strategic planning, and assessment followed by tactical planning, execution and follow-up for results.

I'd like to ask all of us to take a look at the next nine years and try to visualize in our minds what it's going to take to have a consistent momentum in productivity improvement in our organizations. Not some flash-in-the-pan three-month effort here and three-month effort over there. Look at productivity and quality of work life as two sides of this coin. Quality of work life is how all of the players on our team, in our business, feel and think about themselves and about their organization and the pride they have in each. And it assumes that everybody wants to do a good job and that when they do that good job they want to be recognized and appreciated for it. I want to do a good job, and so do each of you sitting in the audience, and we also like the recognition and the appreciation for doing that good job. So let us not think it's any different for the people in our organizations going all the way down to the janitor on the night shift.

Now, let's take a look at the next nine years and see if we can watch it unfolding in front of us as this coin falls in slow motion down through the area. What we first see up here is increased productivity through measurement, and corrective action, then increased quality of work life for our people because they're involved contributing, and feeling some satisfaction in their work; then more increased productivity, then more increased quality of work life, then some more increased productivity, then more increased quality of work life because our people have pride in being members of a winning team. That's to say when the productivity is there, the achievement is there. I know the academics will rationalize this is too simple, but I'm only stating what I've seen numerous times at the deck plate over the past 22 years. That's the American culture. If nothing else, a momentum at a nice steady pace for the next nine years; with an improvement of 6 percent per year in manufacturing requires a total effort by all of us.

Now on the same coin, let's look at the cutting edge. Let's call that the Quality Strategy of doing things right the first time, eliminating waste and delays, and have a long-range defect prevention attitude, rather than a short-time find-it-and-fix-it attitude. That's the attitude that Japan has already internalized so we're behind, but we're really never behind when we have worthwhile measurable goals at all levels of the organization and are progressively moving towards them. All observations indicate significant potential for improvement in the United States if we focus here in 1981. Let us begin by first defining quality in more tangible terms and we suggest production quality and product quality; and second, by measuring and establishing baselines within the next three months for rework, scrap, engineering change orders, purchase change orders, the number of inspectors we have, the number of quality engineers, the percentage of rejects from the fenders to the average days late from the vendors. Study pages 119-126 of Crosby's book. If you don't have time for that, remember Gray's Law: Purity, Precision, and Procrastination kill measurement. Let us focus on

those elements, set some realistic goals, take some improvement actions, follow-up, recognize and appreciate achievements of the people.

I have observed an American work force standing by waiting for the opportunity to get involved in this challenge. They are ready to focus in and be constantly alert to any kind of problem in operations that could adversely affect production quality and product quality. They are proud. They want to be members of winning teams. They realize where their pay checks are coming from. That will happen when we start measuring and putting the data on visible charts so we can all see how we are doing.

This represents one of our most important leverage points in 1981. Profitability equals productivity times price recovery. Productivity can be measured and so can quality. Quality can be measured and it affects that same equation; all we have to do is roll up our shirt sleeves, get down into the plants and start taking some measurements and asking the right questions. We can reverse the trend, it's in each of our hands. It will take getting down to the manufacturing floor, asking the people, and they'll tell us. I also submit that we'll be glad we did and see most satisfying results when top management gets involved in measuring those production quality and product quality elements and challenging for improvements.

Productivity-Quality of Work Life: two sides of a coin, and the cutting edge is quality.

Phillip J. Lichtenfels

Good afternoon. Thank you, Dr. Tweeddale, for the kind words, and I would like to thank the organizers of the committee for inviting me to share with you some of our learning experiences in the application of office technologies within the Public Systems Company of Westinghouse.

I would like to talk with you about why we think it is important to Westinghouse, our target in terms of the kinds of people we think these technologies apply to, our objective for the application of the technologies, how we have applied what we consider proven technologies - proven in the sense that they have utility -and where we can demonstrate, both qualitatively and quantitatively, improvements in productivity. I will discuss experimental technologies, and where we are headed in the application of technologies during the next several years.

First, I would like to describe to you the Public Systems Company. We are one of four major companies in Westinghouse. The other companies are Power Systems, Industry Products, the International Company, and the fourth company, of course, is Public Systems.

We are organized into four groups: the Learning and Leisure Group that markets and manufactures 7-Up, Longines and Wittnauer watches, DataScore, which provides computer and software services, and Linguaphone, which is located in Europe, which markets language training courses; the Construction Group markets and manufactures transportation systems, elevators, heating and cooling, and office furniture systems; the Community Development Group is in the business of developing large tracts of land in Southern Florida; the Defense Group, which is headquartered in Baltimore, Maryland, as many of you know, develops and manufactures radar systems, fire control systems, and so forth. Our annual sales are approximately $2.2 billion, and we are forecasting that these sales will go to approximately $5 billion over the next five-year period. We currently employ approximately 34,000 people, 18,000 of whom are management, professional, and clerical personnel. The balance are hourly employees.

Let's discuss for a moment why the application of office technologies is important to the Public Systems Company. Primarily, because we would like to better utilize the critical human resources which are required to make any company successful. And, if we are to grow, we must better utilize our scientists, our engineers, our draftsmen, and our computer programmers.

I mentioned to you that we have about 18,000 salaried employees. Seventy-five hundred of these employees are professional. If I can improve their productivity by 10 percent, I can, in effect, create 750 new people for the Public Systems Company of Westinghouse.

We must improve our operating performance if we are going to successfully achieve the growth which I described earlier. We must be in a position to better compete with our competition, both domestically and foreign. We all know the threat which we face from overseas in competition.

If you analyze the total cost of doing business in Westinghouse, we find that roughly 54 percent of our employees are salaried. About 64 percent of our total compensation is required to support these employees. In Public Systems Company there are annual salary and welfare costs of approximately $563 million. If we can improve 10 percent in this area, it means that we have $56 million to hire and train new employees where they are required, reinvest in our business, and become a more viable enterprise.

Finally, the need to improve the quality of worklife. We have learned as we apply these technologies that we are able to eliminate a lot of the drudgery and manual effort required in the office area. Rather than manually tabulating numbers or searching files, or traveling, we find that if we can properly apply the technologies, we can eliminate much of these things, providing more time for planning, for designing our products, and improving our qualitative performance and the quality of our work life.

The scope, therefore, in applying the office technologies, is directed primarily to our executives, middle and second line managers, professional employees, and clerical personnel.

The kinds of work that we are talking about are described in the next slide. These statistics, which relate to executive management, other management, professionals, and secretarial personnel, fairly represent the kinds of work that these people are doing, and the approximate percentage of time that they spend in each of these areas.

If we look a little more closely at this information, we find that we spend about 9 percent of our time searching files, 14 percent in writing or preparing documents for typing, 6 percent in handling mail, 13 percent in telephoning, 17 percent in meetings, and about 10 percent traveling -- and this travel time does not include the time that we spend traveling in the evenings or on weekends so that we can arrive at our appointed place of business. So it is in each of these areas that we are directing our efforts in the application of technologies.

Our objectives are to improve office productivity by 30 percent over the next three-year period, and frankly, we think that this is a modest objective. If we can achieve this 30 percent improvement, we could, theoretically, improve our operating performance by $170 million; and if we look at the same 7,500 professional employees that we talked about, we can create the equivalent of 2,250 critical personnel. We think, based upon our experience to date, this objective improvement of 30 percent can be achieved. If any of you may have read a recent article about an experiment that was conducted by the Air Force in a controlled environment, they were able to improve productivity by as much as 50 percent.

Our second objective is to evaluate terminals and communications technologies. As many of you know, in an executive environment, it's been a long time since these people have sat in front of a keyboard.

You can likewise say the same thing about our middle managers, our first line managers, and most of our professional employees. We think that the best way to put computer power at the fingertips of our employees is through the use of CRTs. We're predicting that within the next five years, we will have at least one terminal for every two employees. This means that we would have as many as 9,000 CRTs tied into our computer network by 1986.

Our third objective is to evaluate the use of electronic data bases. These data bases are not the typical or traditional data bases which we normally associate with large-scale computer processing. The data bases which we are talking about here are better described as personal data bases where professionals or managers, and in some cases, executives, utilizing the CRT, simple programming languages, and time sharing computers, are creating data bases which most directly relate to the work that they are doing.

During the past two years we have had two parallel experiments in trying to apply office technologies: one, through the use of electronic mail and time sharing services; the other through the use of traditional data centers and computing processes. We have been much more successful in the use of time sharing computers and simple data base languages than we have utilizing the traditional methods.

Our fourth objective was to determine the feasibility of a single office productivity system -- one that will be integrated with our traditional information systems, one that will utilize a single, multi-purpose work station. Our next objective is to determine the benefits and attempt to quantify the benefits of applying these technologies, and develop recommendations for Westinghouse.

If you look at this picture of an office in 1894 at one of our Westinghouse locations, you will see a young lady with a dictating pad, utilizing a mechanical calculating device. In the background, telephones, and on top of the roll-top desk is an electric fan. How very similar that is to most of our offices today. Very little has changed in the 87 years that have passed since this picture was taken. And if you think about what we see here, and you relate to what we see in most of our offices, things haven't changed very much.

Technology has changed - technology provides us with lots of tools that we didn't have in 1894. Our challenge, therefore, is to try to apply these technologies to improve productivity. If you examine a little closer the tools that we provided during those times for typing or preparing information, we see a picture here of a 1910 model Royal typewriter, and how very little has changed as far as most of the typewriters that we're using today. We have an electric keyboard, but nothing much else has changed.

We think, and I think you will agree with me, we have a long way to go in improving productivity in the office area.

I'd like to talk next about technology status and the technologies that we think have proven utility.

Manual filing procedures. And you say, that's really not much of a technology, but as far as we're concerned, it's like blocking and tackling in football. It's the place where most of our information is stored, and if we are to substantially reduce the amount of time that we spend searching files, we've got to get the majority of our information organized so that we can reduce the 9 percent of our time that we spend searching files.

Other technologies include telephone dictation, word processing. word processing communications, facsimile transmission, intelligent copiers, audioconferencing, electronic mail, and voice message switching. A year ago, when we first developed a list of technologies that we felt had proven utility, it did not include voice message switching, electronic mail, audioconferencing, and intelligent copiers. We have worked enough with them during the past year to know that we ought to apply them as quickly as we can.

Let me next demonstrate for you some of the things that we have done in the application of these technologies.

Here is a picture of my office back in Pittsburgh, where we are demonstrating a standard filing procedure which we are implementing within our staff organization at Gateway. You might think that a large corporation like Westinghouse would have a standard filing procedure at its headquarters, but we did not. Everybody did their thing their own way, so if you

were looking for information that was outside of your own area, it was difficult to find. And, for the most part, within our areas it was difficult to find.

This system that we're applying is basically simply a color-coded system where we are providing an index to our word processing centers. Where we have applied the new system, for example, in my area at Headquarters, we were able to reduce 50 linear feet of files to 18 feet, reducing substantially the space required, creating a common index for all of the people in our organization, and improving substantially our ability to find information in our files.

We are providing telephone dictation for all of our executive management, professionals, and even our current secretaries, and we do encourage our secretaries to use telephone dictation. This telephone dictation is provided 24 hours a day, 7 days a week, and it doesn't mean that we've got people in the word processing center. We have equipped it with this dictaphone answering equipment, so any of our people, if they are in the office, at home, or traveling throughout the world, as long as they have a telephone they can call in to the telephone dictation service and dictate their letters or messages into our electronic mail system, and I will talk about that interface in a moment.

One of the keys to our success is the service levels that we are offering for all of our people. Normally, we try to turn letters or documents around in a four-hour period. We'd like to be able to provide this service almost as quickly as if they were using their personal secretary.

Through the use of the touch-tone pad, if a person required immediate service from the word processing center, they merely touch the "0" on the touch tone pad, and one of the word processing persons will come over and pick up the phone, take whatever special instructions are required, and get the work back to the principal as quickly as possible. This kind of service is critically important to the success of this particular technology.

I should tell you that we have changed the name of the word processing center to the Information and Communications Center because of the way that we have used the systems to communicate. However, we're using word processing for general correspondence, manuals, and proposals, communications, pattern recognition, or OCR. We have installed intelligent copiers and, in some cases, photocomposition devices.

I'm sure that most of you have worked with word processing equipment. We have attempted to establish word processing centers in the past using conventional typing equipment, or using mag card equipment, and we were not successful because we didn't provide the tools that are necessary to make a word

processing center successful. The word processing provides a lot of flexibility. We know that you can prepare a document in 30 percent less time than it would take you to prepare a document on a conventional typewriter. We know that you can make changes in less than 50 percent of the time that it took to make changes in the past. Understanding this improvement in productivity, we can relate the statistics which we keep very religiously, and identify, in quantitative terms, the savings that we have been able to achieve.

In our headquarters operation we analyze (and we do this monthly) our operating statistics for the month of February. In typing original documents, we saved approximately 68 hours. In making changes or revisions, we saved 119 hours. And through the use of dictation by the principals, we saved 205 hours. This last statistic is based upon studies which we have done where we find that people utilizing telephone dictation can do it five times faster than if they were writing manually or dictating to their secretaries.

I mentioned to you the use of the word processing center for communications. By merely adding a modem and a telephone, you are able to communicate with other word processors very effectively, and to our electronic mail system. Here we see some of our word processing operators utilizing this device. We are routinely communicating between Pittsburgh and London, between Pittsburgh and Brussels, or Spain, or Morocco, in all of our domestic locations where we have established word processing centers. I should also note that we have standardized the word processing hardware to facilitate our ability to communicate.

In our word processing centers, we are also providing facsimile transmission equipment. The device which is shown here has the capability of transmitting a page every three minutes. Many improvements have been made in the facsimile technology during the past year, and there are facsimile machines on the market which will transmit a page a minute. We find that this is a very effective way of communicating.

We have installed a laser printer. This is a picture of an IBM 6670 intelligent copier. It is probably one of the most effective tools that we have provided in the past several months to improve our productivity. The system is tied directly into the word processing system, so that when our operators have completed keying in a document, they transmit that as an electronic message to the copier, and it produces the hard copy output.

It prints both front and back, and will produce about 13 copies a minute. You will notice that it also includes a collator. So now when we have finished a document in word

processing, rather than taking a hard copy, giving it to the secretary, having her go to a copying machine to make copies, we can do it automatically.

We recently conducted a study of the amount of time that our secretaries spend at the copying machines. We found that in a group of 14 people, it's about 40 hours a week. We think that we can reduce that to about 10 hours a week through the use of this device. As many of you know, intelligent copiers are coming out where we can digitize our signatures, so that we no longer have to bring the letter back to the office to have it signed. Obviously, there are a lot of legal ramifications regarding this technology.

In the area of audioconferencing, we have found a device called Northern Telecom 2000 System. It is a telephone and speaker system which is manufactured in Canada, and it is an extremely sensitive and highly effective tool. We are currently installing one of these in each of our major offices throughout the Public Systems Company.

Here we see a meeting which was being conducted in our Gateway offices with architects at our Grand Rapids office in Grand Rapids, Michigan. We are currently involved in installing new work stations for all of our people, and we were reviewing their proposed drawings. In this one instance, we paid for the cost of the audioconferencing device. The device, incidentally, sells for about $850. When you add up airline tickets, parking, dinner, hotels, meals, you find that the cost for the trip for the two of us would have been about $900.

Another device which we are installing in our audioconferencing rooms is the same facsimile machine which you've seen installed in our word processing center. We found that about 90 percent of what you want to achieve in audioconferencing can be realized through the audioconferencing device, which I discussed earlier, and the facsimile machine, so that if you do want to to send a hard copy to the other end of the line, the system is available.

One of the other proven technologies is the service which we call the electronic mail system. In this technology, we have equipped most of our executives and staff management personnel with CRT terminals. The system utilizes a time sharing service called DialCom, of Silver Spring, Maryland. Through the use of this system, we are able to scan our incoming mail, read the documents which we decide to review after having scanned the mail, send messages, file messages electronically, and archive messages in off-site storage capabilities. Through the use of this electronic mail system, we have been able to improve substantially the amount of time that people spend handling correspondence.

In cases of our executives traveling, we are providing portable TI Silent 745 terminals. The people that are using these systems can take them with them on trips to other locations, or can utilize them through the acoustic coupler in their hotel rooms at night.

As the implementation of the electronic mail system has spread throughout the Public Systems Company, we find it becoming unnecessary to carry the portable terminals, because most of the locations now are equipped with CRTs into the system and when you arrive at a remote site, you can generally do your mail processing on that terminal.

In January a year ago, we started out with 15 mail users in our executive offices, and the system has now expanded to over 900 users.

Another technology that we have been working with is voice message switching. It provides the same functions as electronic mail. You are able to scan your incoming messages, listen to messages which people send you, redirect messages to other individuals, and to archive messages. For example, if, in utilizing the voice message exchange, if Dr. Tweedale were to call my number, which will answer 24 hours a day, 7 days a week, and leave a message, when I arrive at the office the next day or access my voice message box, I can listen to the message, and respond immediately through the commands that are available on the system. Or, if need be, I could forward the message to another individual who might want to provide additional information or who I might give instructions to to answer what Jerome's question might be.

We have found the electronic mail system and the voice message exchange reduces substantially the amount of time we try to spend contacting people on the phone.

Studies have shown that about 70 percent of the phone calls that we make to individuals do not result in reaching that person directly. It's a problem of leaving messages, calling back. Through the use of these two technologies, we think we will be able to reduce substantially the amount of time that people spend in telephoning, and in handling their mail.

There are several technologies which we are still experimenting with, and will continue to experiment with. These include teleconferencing, electronic filing, micrographics, optical character readers, and perhaps the most important technology of all, personal computing, which includes graphics, schedulers and ticklers, and data bases.

In the case of teleconferencing, we have been experimenting with the public rooms that are available through AT&T. I'm sure that many of you are familiar with these rooms. They are currently located in about ten cities throughout the United

States. They provide full-motion conferencing services. In this slide, you see the control panel, which the principals can use in controlling the meeting. The rooms are designed to accommodate six people at the conference table, with space in the back for additional personnel. The cameras are voice actuated, and will focus on the individual speaking, as demonstrated here. The monitors which are provided will show the pictures which are being sent, the other conference room, and pictures being received from the conference room. In this instance, we were conferencing between the Pittsburgh installation and Washington, DC. The conference rooms are equipped with chalkboards and spaces for chart material.

Here we see one of our analysts describing a communications network, and you will note through the camera we can focus in on what it is that he's saying and transmitting to the room in Washington, DC. At this particular meeting, which was a meeting of our Public Systems office productivity planning council, which, incidentally, meets once a month, we spent $247 utilizing the two rooms. The airfare for the individuals in Baltimore to come to Pittsburgh would have been approximately $600.

The problem with full-motion videoconferencing is the cost of the rooms, which, if you want to provide capability similar to what we are discussing here, cost about $350,000 for cameras and equipment to provide full-motion capabilities. It also requires extremely large communications capacities. Full-motion videoconferencing requires about six million baud capacity of lines. To install such a communications link between our Gateway Headquarters and the Baltimore Defense Center would cost approximately $20,000 a month.

We do think that there is tremendous benefit from full-motion videoconferencing, and think that in the coming years the cost of providing these kinds of capabilities is going to drop dramatically. We're following the technology, we're experimenting with it, we think it will be extremely useful in reducing meeting times and travel times. Last year, Westinghouse spent about $120,000 on airline tickets, bus tickets, and private transportation. Through these kinds of capabilities, we should be able to improve productivity substantially.

Another area which offers a great deal of benefit is the use of computer graphics. Here we see demonstrated a Three Rivers Computer Graphics System. This system provides the capability for our financial analysts and for our executive personnel to take financial data and translate it into a myriad of graphical expressions. This particular system is being used by our Construction Group routinely for the monthly operations meetings, and when Bill Coates, our Executive Vice President of the Construction Group, presented his long-range strategic plan for 1981, he utilized this system very effectively.

Another area which offers potential through the use of the CRTs is the schedulers or ticklers or reminders where people can maintain personal schedules, schedule meetings, issue reminder notices, and provide bulletin-board capability for the users of our systems. We are still experimenting with these particular applications, because the system which we have available to us is somewhat cumbersome to use, and requires significant and complicated input. We think that as these capabilities become more sophisticated --become as simple as writing in a calendar book a meeting that you have scheduled -- the use will become more widespread.

Another area that we've been experimenting with is the development of electronic data bases. I mentioned earlier in my discussion that for years we have had the traditional data bases which are resident on our large-scale data centers. At best, these systems are complicated to use and, because of the controls required for these large, multi-purpose systems, it is difficult to make simple queries into these systems.

When we installed the executive terminals in our top management offices, we also began experimenting with personal data bases, utilizing the CRTs and the capabilities of the time sharing vendor who provides our electronic mail services. We have developed financial data bases for the Construction Group of the Public Systems Company, developed key personnel systems, competitive analyses, access to the United Press International News Services, and banking service directories.

We find that these kinds of simple, personal data bases become extremely useful, and through the use of simple data base management systems (in our case we use something called INFOX), we find that many of our people are developing personal data bases and using INFOX to access these data bases and prepare reports. These capabilities should substantially improve our ability to plan and analyze the information which is available to us.

Another extremely interesting experiment is the use of home computers. We have installed at our staff level in Pittsburgh approximately 50 home computers. We are using the Radio Shack TRS 80 Mod II and Mod III, and the Apple Computer. These systems are installed in the homes of our executives and managers. They are being used as terminals into the mail system, the developing of personal computing, word processing, or text editing, and perhaps most importantly, providing a technical awareness for the executives and managers that missed this kind of exposure during their formal education.

Here we see illustrated the use of the TRS 80 Mod II. Dave Aynardi, who is one of our senior information analysts, has developed basic programs, using the graphics capability of the TRS 80, to analyze and report on the use of the electronic mail systems and public data bases in our information network.

There are currently about 275,000 TRS 80s in the United States. There are also several thousands of other home computers which have been sold. Because of this large population of home computers, a whole new industry has evolved for the development of software packages and pre-programmed applications for use by the owners of these home computers. They include business, engineering, mathematics, statistics, and probably most importantly, the games that are available for the system.

In one instance, we installed home computers in one of our engineering departments in the Transportation Division, and opened up whole new vistas of computer applications for these operations.

I'd like to speak for a few minutes, then, on where we are headed with these technologies. At our headquarters operation in Pittsburgh, we have a pilot operation where we are going to install work stations which have been designed to accept the technologies we are working with. This mock-up illustrates a professional work station where we have installed our new manual filing system, where we have provided a place for the CRT which all of our people have been provided, and you'll note the paper handling arrangement of the work stations. In many ways, it's similar to the slide which I showed you at the beginning of our discussion in that 1894 office environment, where we've created cubbyholes so that the persons working in this environment will have at their fingertips all of the information that they need.

We will provide our secretaries or administrative assistants with similar work stations, which have been arranged to provide access to all of the tools and all of the information that they need to carry out their responsibilities.

For our executives and executive managers, we'll provide work stations similar to the one illustrated here - CRT, filing systems, and the paper management capabilities which we have discussed earlier. On the 18th floor of our Gateway Building, we'll provide an Information and Communications Center, which will provide telephone dictation, communications, printing and central filing. The floor will be equipped with three audioconferencing rooms and a room that has been designed for full-motion videoconferencing when that becomes economically feasible.

Throughout all of the Public Systems Company, we are installing Information and Communications Centers, audioconferencing capabilities, facsimile transmission, electronic filing, and personal computing capabilities. As I mentioned earlier, our objective is to improve the productivity of our managers, professionals, and technical people by 30 percent. We have every confidence that we can achieve that objective.

Thank you very much.

Question - (Unintelligible)

Mr. Lichtenfels

I mentioned early in my presentation that one of the things that my boss did was decide that if we were going to experiment with that we needed to put some developmental funds aside. If you think about it, if someone wanted to develop a new material or a new manufacturing process, we probably would have R&D money for doing that and we look at this as being R&D money. So on an experimental basis, in the particular case of our staff at Gateway, I had a productivity fund of $300,000 last year and we used that as seed money to pay for the terminals, the time-sharing services, and some of the word processing capabilities. And after six or twelve months, we said we were either going to take it away or keep it. We were satisfied that it was justified and that it had improved our productivity. But when we put it out into the organization, we developed the position papers, we understand where the savings are, we understand how it should be implemented, and in what way it should be most effectively implemented. We've been trying to develop the product projects or experimentation and then proliferate it throughout the Public Systems Company.

Question

Are we creating an isolationist cult by using these kinds of systems and is this a form of gimmickry or is this a viable form of technology?

Mr. Lichtenfels

In answer to the gimmickry question, first, I get that response a lot to some of the things that we're doing. My answer to that is that we've tried to experiment with these technologies in a controlled way. We don't just put them in in a haphazard manner; we've defined the communications protocol and we've defined the screen sizes, so that we know that they're going to be able to integrate into the system. In each case, we try to clearly define a set of objectives of

what it is that we're trying to do so that we can measure that performance as time goes by. We'll never know how we can use these technologies until we try them. We'll never know how we can use these technologies - I say that over and over again. And every day that I go into my office, somebody has come up with some new way of taking advantage of these things. All the brains are not in the information system. I'm an old traditional information systems guy, and typically, the way that we would have addressed the questions or defined these things would have been to put an analyst out on the job and he would have gone and made a study and the would have come back with some recommendations and we'd have said, "Here it is - implement it." Now, one of the other things that I didn't mention that we think is very important is the Quality Circles concept. We make sure that our people get an opportunity to participate in these processes. We have a Quality Circle that says where all of the secretaries meet once a week and their objective is to try to figure out how we can best take advantage of these technologies that we're talking about. In doing that, they've gone out and they've developed logs of how they're spending their time, they've addressed important problems, so we've tried to implement it in a controlled way, in a controlled experimental way. We think that a lot of the technologies will not be implemented until we get a better understanding of them. So that's my response to that question. There is a danger, I think, in creating a little office that you're working in that you never leave - everything is right there in front of you. We do have a man in one of our locations who is in a very high level position, who recently reorganized that organization and put it all in the computer and he wrestled it around and sorted things out and came out with the answers and never talked to anybody about it. That created a real problem. I think we have to balance the - hopefully what we're doing is allowing managers more time to manage, to develop people, to counsel people, to work with their people, to interact more properly. Hopefully, we're allowing people to do more analyses and spend more time in doing creative things than they've been able to do in the past. We've got to keep all of this in balance. And I agree with you that there is a danger in that. There's a danger of putting somebody into an electric tube and not having him interact with anyone. We're trying to be very careful about that.

Question

Are the results of these applications and studies documented and available?

Mr. Lichtenfels

Yes. We'll be glad to share any of that with you. As a matter of fact, I will extend an invitation to any of you to

visit with us and talk to us and come and view this thing. I'm very much interested in sharing our learning experiences with people. My boss is extremely interested in making sure that we share these learning experiences, so I extend an invitation to all of you and if you would like some of this information you can leave it with Jim and I'll be glad to send it to you. We've documented most of the technologies and we've developed a strategic statement of direction of how we're going to implement them throughout the Public Systems Company. We'll be very happy to share that with you.

Dr. Tweeddale

I'd like to thank Mr. Lichtenfels very much for an excellent presentation.

The final presentation of the day is going to be presented by Mr. Louis Sportelli who is the Director of Manufacturing, Federal Systems Division of the IBM Corporation. Mr. Sportelli joined IBM in 1957. Since that time, he has held progressively responsible positions in engineering and management and in manufacturing. In 1979, Mr. Sportelli was appointed as the Director of Manufacturing at IBM Federal Systems Division headquarters in Bethesda, Maryland. In this capacity, he has Division staff responsibilities for manufacturing, product tests, material management, product assurance, product engineering, and manufacturing and test engineering. He has a B.S. degree in Mechanical Engineering with graduate studies at Northwestern University. Mr. Sportelli is a member of the Executive Committee of the Manufacturing Technology Committee of E.I.A., the Manufacturing Committee of A.I.A., the Productivity Ad Hoc Committee of E.I.A., and is currently Vice President of Virginia State Chamber of Commerce. It is indeed my pleasure to present to you at this time Mr. Sportelli.

Louis G. Sportelli

Thank you, Jim.

As you can tell, you probably can't see me, but when I was in the Army we used to go on speed hikes and they always put the short guys in the back, which meant that I had to run to keep up with the hike and you're only supposed to walk.

I'll talk to you a little bit about strategic planning and I'll talk to you a little bit about operations strategy as we know it in FSD, and some of the automation things we're going, and then I'll talk to you about what we call Circles of Excellence, which is a spin-off of the Quality Circles, but we don't like the word Quality Circles and I'll tell you why when I get to that.

To me, strategic planning is looking at the future impact of the process of making sure that you go through a rigorous process of planning for the future and the philosophy and structure that you would normally use when you go through a planning process.

This is what I think it is not. It is not a road map; it's not something that gives you a products sales forecast. The only thing that I see in strategic planning is not only the fact that you go through all this thinking process, but also that you are trying to structure what your decision-making may be for the future.

A question might be asked, "why do it." These are the kinds of answers I would give as to why you should do strategic planning. Most of you probably do strategic planning already, but these are some of the reasons why we do it in IBM and in FSD. It does have limitations. The business environment that we're in changes very rapidly, and so a lot of the things you do, you've got to make sure it's only a framework, it's only a base. It's not the kind of thing that you're going to adhere to 100 percent, but it does give you a frame of reference. One of the key things is that planners are not responsible for the strategic plan. Senior management should be responsible. They're the ones who have to be involved in it; they're the ones who have to make sure that the planners are only the technicians and only the people who put it together and collect the data.

I've cover very briefly what the process is, at least in our company. First, the missions and goals have to be established. You have to have the long-range objectives. You have to have some strategic direction, what things you're trying to accomplish. You have to have detailed strategies, of course. Otherwise, it would be just a document which would not be used very readily. Another way of putting on the same planning sequence - you get from Corporate the missions and goals. They establish what they want the Division to do, in our case at least. Then it goes right on down through senior management, middle management, to low manager.

In FSD, we try to determine first where we have been successful, so we build on our strengths. Secondly, we try to determine at what cost have we had this success - has it used up too much of our resources, what are we trying to do, where are we trying to go, and then can we really get there with what we have. We try to put together all of our many programs in our Division, first by sales to see which ones are providing us with the major sales and, of course, which ones are not. Then we put together a profitability matrix to see which ones are profitable and what are the percentages, and, of course,

everybody always has a few negative margins. We put our programs on this kind of a matrix to see what profits we are getting versus what resources, and we try to make a determination as to which ones should be cut out, even if they are reasonably high profit. If they're using up too many of our resources, we may try to cut it out by not bidding any follow-on or bidding in the same application area.

In FSD, we have some good programs and we have some poor ones. Some of them are using a lot more resources than we want to use, and so again, we are making a strategic decision as to whether we continue in that application area or can we perhaps correct some of the problems by finding a way to use fewer resources.

In our planning process, we have a BATAS plan - business area, technical area strategy and it's a five-year plan. We put that together in the Spring. Some of the areas that we cover in the plan make sure that all the functional areas that we have support the plan and also come in with their functional strategy which would be part of the plan. The management role in planning, of course, is the key role in planning. It must recognize and accept planning as a significant responsibility and management must be involved.

Some of the planning pitfalls - we assume that the planning can be delegated to planners in most companies, and of course that's wrong. Planners don't really know the marketplace, they don't really know what's going on unless they're told, and therefore, they're really data collectors.

I think you have to compare plan to plan to see how good your plans are. It's not a one-shot deal - you have to continually check out your plans to make sure that in a previous year if you did a poor planning job in certain areas, why did you do a poor planning job, and what can you do about it.

Planners can assist - they do have a professional capability and if you use it properly, I think that they are very helpful in the planning process.

I'd like to spend some time on the operation strategy and automation, again, as we do it in FSD, and some of the things that we focus on, some of the things that we're concerned about. First, we're worried about acquisition controls and manufacturing controls. We find that we can buy things at a relatively low cost if the buyers are doing a good job, but then when it gets into the facility through receiving inspection and distributed out through the floor, we sometimes lose control. So we put together a plan where we focused on the acquisition control of not only the cost but also the controls on how we get that part

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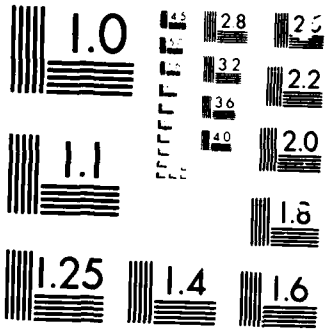
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out to the floor, avoid floor loss, avoid problems of losses by misplaced parts, etc. We also worry about the manufacturing controls because once it gets out in manufacturing, we have to make sure that we know where that part is and that it doesn't remain in queue too long. A previous speaker talked about that - the queuing is a big problem. If it sits for 95 percent of the time awaiting to be worked upon, that's bad. In our organization, we're improving that in a lot of ways, making sure that we've gone through the entire process and any place where we have a bottleneck, we either buy more equipment, put more people in that area and make sure the bottlenecks are eliminated and that we have a smooth a flow as we know how. We do have early entry into the design process. We try to co-exist with engineering. A lot of us have been in engineering in the past and we know what some of their problems are and also know what some of their thought processes are. What we try to do is work very closely with them, making sure that the ME and the Product Assurance people in any way influence the design.

We do have a cost management technique that we use. We watch the costs in all areas, we accumulate those costs by cost centers, and we accumulate the costs by functional areas.

Early problem prevention is one of the things we're working out which I think is very important. We seem to have a good facility of detecting problems, but we don't seem to spend as much time in preventing the problem to begin with. We have a few techniques in our Division that we use. The first technique is the cost reliability/manufacturability/maintainability design review. We have people from those areas review the design before we release it to the floor. So before we do anything about buying parts and putting assemblies together, we make sure those people are satisfied that the designers have understood the problem and are doing the best they can for manufacturability. We also make sure we have design standards and we have an approval loop if you violate those design standards, so exceptions are handled by upper management. We also have production readiness reviews, which is really a take-off on what the Navy does with us and other contractors. Then we have a lot of techniques for early problem detection. Obviously, you should detect the problem as early as you can. We have screening at the . . . , mostly with the vendor, but we also do some in-house. Then we run audits and we run some functional tests like the test to analyze and fix, to try to mature the product as early as possible before we ship it out in the field. All this, of course, will result in better reliability and better availability if done properly.

We are working on automation robotics in CADCAM. Everybody has talked about CADCAM. We have CADCAM that we've been working on for the last few years. All new products that we design in

FSD is on that system and that gets released to manufacturing engineering, who in turn writes the . . . and comes up with the process specs from that. We also have other things like we've looked at labor-intensive operations and tried to automate them. We have low volume and small job lots, and so we're looking at programmable robotics so that I could use a robot for six or seven hours doing a particular job and then I could switch that robot to another job by putting a different program on it. This is the kind of automation we're going to. We're also trying to work that into a comprehensive manufacturing system so we don't have isolated pockets of robots that don't tie in altogether.

We do have indirect productivity measurements. This is a corporate-wide program. It's run by the Corporate Vice President of Manufacturing because we have the philosophy that the manufacturing people - I'm talking about operations, all the things that go into operations like materials management, product assurance, and so on - we feel that we have the biggest stake in indirect cost, since that affects our burden rate, which affects our competitiveness. So we have the manufacturing or operations people responsible for areas, even though it doesn't come under their direct control, like secretarial or administration, or facility engineering, which would not normally come under that control of manufacturing. We've broken it down into functional areas, activity, and what we call indicators. We have all of our facilities under that system, so we come up with a norm by just averaging by the number of facilities. But that is not as important as the productivity measurement, which is really measuring yourself against what you did last year. Those are the kinds of measurements that we have in the indirect area.

I want to talk to you a little bit about our Circles of Excellence Program. We started the Circles of Excellence Program about a year ago and the reason we started it was not - again, I have the responsibility for it, but it's not because we only have it in Manufacturing. We call it Circles of Excellence because we have Circles in all of the areas. We have 95 Circles and we expect to have more. We have circles in Administration, Information Systems, Operations, Facility Engineering, Engineering Programming - because we think these are the areas where you can get the most pay-back.

Our objective is a very simple one. We always tie productivity and quality together. We believe that the highest form of productivity is doing it right the first time. We think that by having excellence in productivity and quality, it leads to more effective teamwork, and we also think that this enhances the manager-employee relationship. Our program is a voluntary program. Some of the managers have to be a little

bit coerced into starting a Circle. Once they start a Circle, though, they seem to pick up quickly. We have run some opinion survey data that shows - and we matched demographics so that it's an apples-to-apples comparison of like areas - and we have been able to find out that the opinion of the manager by the employee goes up considerably when they have Circles versus the non-Circles. It's a sharing kind of relationship between the manager and the employee, and the employee seems to really love it.

This is why we have Circles. We not only want to boost quality and productivity, but we are trying to change the attitudes of people. We're trying to get them to realize that we are trying to harness their brains, not just their arms and legs, and we're trying to make use of the fact that the expert is the person who is doing the job and they know how to improve it better than anybody else.

Our Circles program is a voluntary program by the people and also the managers. It's Division and Facility coordinated. We have found in our Division that if you coordinate it out of the Division you get uniformity, you get consistency, and you make sure that all the facilities are treating the program the same way. We have top management support from our President and we do provide training. We've trained what we call Coordinators, which other people call Facilitators. They, in turn, train the managers; the managers in turn train the people who are in their Circle. We have both multi-discipline Circles and Department Circles. Department Circles are classical. In the multi-discipline Circles, we try to tie together departments from different functions that interface with each other and we select a Manager who agrees to head the Circle and we have members of the Circle from different departments. That's been also very successful.

Some of the typical problems that these Circles have been coming up with are insufficient manpower and budget, outdated procedures and plans, telephone system inefficiency, department needs broader role, ineffective use of storage space, excessive reporting and record-keeping, unresponsiveness of the support departments, lack of awareness on related activities, insufficient detail in technical documents, excessive rejects, wrong parts supplied to the manufacturing room, incorrect documentation, inefficient organization, poor maintenance program, lack of proper equipment, limited authority to do the job, poor quality and slow turn-around, "make work" activities, inadequate long-range planning and tracking, procedures that inhibit optimum product flow, and excessive time required to process documents. These are the things that the Circles normally come up with. Most of these Circles when you go through a technique and teach them how to brainstorm - a lot of people, especially

the non-exempts or the people in the manufacturing areas - don't know that technique. After you teach them brainstorming, they normally come up with as many as 50 items that they perceive as problems. Some of them are not real problems, but at least they perceive them. And then you go through the cause-and-effect diagrams and show them how to prioritize those things.

The reason why I think Circles work is because the people now become owners of the problems. In the past, Managers owned the problems and the people may or may not have been asked to solve the problems. We normally don't listen to our people, even when they talk, but this provides a forum for listening. It also provides a forum for them to come up with their ideas and they get peer acceptance and recognition and that helps with the program, too. The program works very successfully for us. We would not do without it now that we've started it. We're very enthused about this program.

If you talk to the experts - and some of them are consultants - the least pay-back you'll get is two times your investment. Most likely, five to eight times. We've already experienced six times and we think we can experience at least ten times within the next six months....ten times our investment. Normally, you start off by taking an hour off work each week, company time, one of the 40 hours, and you get your Circle meeting and start the planning processes, and then you start doing some of the work and brainstorming, and so on. A lot of the Managers were afraid that the loss of 2-1/1 percent of the 40 hours would be a problem and that the output would go down. That's not what we found. We found that the output has not only been offset (the 2-1/1 percent) but it's been offset by more. People seem to be more enthused, they seem to understand their jobs a little better, and they seem to work together better. I think we can easily get 10 times our investment. One of the consultants told me that in Japan, the joint union of scientists and engineers said they get 80 times. I think that's a little high, but that's what Japan thinks.

There are 5 percent of companies using the Circles now and we think that a maximum of about 50 percent of the companies will be using them. The biggest problem is lack of middle management support and we've taken care of that problem. We have Circles at the middle management level. We have Circles horizontally and vertically, so we have Vice Presidents and General Managers of our facilities who have Circles within their people, and these are meetings where they don't talk about programs, they don't talk about profits, they don't talk about things like that. All they talk about is how can they improve the efficiency of the organization, how can they make the facility a better place to work.

So that's the end of my pitch. I would recommend that if you want to be a little bit more concerned than you are already, you might want to get the committee report from the U. S. Government Printing Office, "The Ailing Defense Industry Base Unready for Crisis." It came out in December of 1980. It's a pretty good report.

Thank you.

Dr. Tweeddale

Are there any questions for Mr. Sportelli?

Question

Is the productivity improvement a part of that strategic plan and is the evaluation of your managers, your annual performance evaluation, a part of the overall productivity enhancement project?

Mr. Sportelli

The answer is yes, but I would like to say that it's only been in there for the last couple of years. We didn't have it in there before. We have each functional area come up with productivity improvement. They also have to come up with how they want to be measured, and then we have an independent group review how they want to be measured to make sure they're not pulling a con game, and also making sure that the measurements are in place. We do have productivity - it's a big thrust. We also have a major thrust in quality in our Division, because we're trying to make sure that since we have a good reputation we maintain it; if we don't have a good one, we improve it.

Dr. Tweeddale

After sitting through a couple of days of sessions, I guess the question is what happens from here. The Productivity Principal in the Air Force, Colonel Jack Bujowski, developed the logo that is driving the Air Force's productivity program. In the logo he has a statement that says, "Ultimately, it all gets back to us." What we've been observing for the past couple of days is really a menu of opportunities, and while there has been attention drawn to exemplary practices, certainly those that fit your organization are contingent upon the requirements of the organization. I came into the Navy productivity program arena about three years and saw that that was what we had to start - building on the requirements of our industrial base.

There have been those in the Department of Defense and in industry who have evaluated the nature of the threat that

addresses national security today in the 1980s. Cost growth has been targeted as the greatest singular threat to national security. Admiral Whittle has said on more than one occasion that the marketplace is costing the Naval Material Command out of business. We've never had a greater backlog of unfunded and unprogrammed opportunities than we have today, right now. The only way to have a strong national defense is to have a strong industrial base and the only way to have a strong industrial base is to have one that is maximally productive.

So as I viewed sessions such as this, I believe it supports some of Admiral Whittle's opening comments that this is an opportunity for managers to exchange information, to view some exemplary practices, to exchange ideas, and possibly input into the process a degree of momentum and leverage. Hopefully, you found these sessions this afternoon, this morning, and yesterday productive and beneficial. I know that I have.

And this is a first event where ADPA and Navy have participated in a conference such as this. If you found the conference worthwhile for your organization, if you found the attention focused on these kinds of practices informative and useful, talk it up. We'd be interested in feedback.

At this point, I'd like to turn the mike over to Captain Nelson Jackson from the ADPA for some comments.

Capt. Nelson Jackson

Thank you, Jim. Oh behalf of the Association, we appreciate this opportunity to join in a very vital subject and we will look forward to enhancement of the subject matter and further participation in developing the issues.

PRODUCTIVITY MEETING

LIST OF ATTENDEES

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